TWO CONCEPTUAL CHANGE STRATEGIES AND JUNIOR SECONDARY SCHOOL STUDENTS' LEARNING OUTCOMES IN BASIC SCIENCE CONCEPTS IN KWARA STATE, NIGERIA

BY:

GBEMIGA JACOB AROWOLO
MATRIC NO: 102140
B.SC. ED. (INTEGRATED SCIENCE) (ILORIN)
M.ED SCIENCE EDUCATION (IBADAN)

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ABSTRACT

Basic Science is a useful subject for developing scientific knowledge and technological skills in young learners. However, students' achievement in the subject is dwindling at the junior secondary school level. Numerous efforts made to resolve the problems notwithstanding, little success has been achieved. As part of the sustained efforts in finding new ways of boosting students' achievement, this study investigated the use of two conceptual change strategies (Simplex and Cognitive Coaching) and the moderating influence of mental ability and self-concept on students' learning outcomes in Basic Science.

The study employed a pretest-posttest, control group, quasi-experimental design, using a 3 x 3 x 2 factorial matrix. Intact classes made up of two hundred and twenty three students, having high, medium and low mental abilities, from six secondary schools in Kwara state were randomly selected. Eight instruments were used for this study: Teacher's Instructional Guides for: Simplex, Cognitive Coaching and Conventional method; Basic Science Concepts Achievement Test (r = 0.73); Attitude Towards Basic Science Scale (r = 0.83); Mental Ability Test (r = 0.67); Self-Concept Inventory (r = 0.79) and Basic Science Conceptual Change Debriefing Protocol (r = 0.67). Two research questions were answered and seven null hypotheses were tested at the 0.05 level of significance. Data were analysed using Descriptive statistics, Analysis of Covariance (ANCOVA), Scheffe post hoc test and graphs.

The two teaching strategies had significant effect on achievement in ($F_{(2, 204)}$ = 10.624; P < .05), attitude towards ($F_{(2, 204)}$ = 4.360; P < .05) and retention of ($F_{(2, 204)}$ = 32.602; P < .05) Basic Science concepts. Students exposed to Simplex strategy had the highest post-test mean score ($\bar{x}$ = 9.32) on achievement in Basic Science concepts, followed by those of the Cognitive Coaching strategy ($\bar{x}$ = 8.85) and the Conventional method ($\bar{x}$ = 7.68). The students taught with Conventional method had highest mean score ($\bar{x}$ = 53.28) than the Cognitive Coaching strategy ($\bar{x}$ = 48.69) and the Simplex strategy ($\bar{x}$ = 46.55) on attitude towards Basic Science concepts. For retention of Basic Science concepts, Simplex group had highest mean score ($\bar{x}$ = 7.84) than the Cognitive Coaching group ($\bar{x}$ = 7.67) and the Control group ($\bar{x}$ = 4.91). There was significant effect of mental ability on students' achievement in ($F_{(2, 204)}$ = 7.600; P < .05) and on their retention of ($F_{(2, 204)}$ = 8.518; P < .05) Basic Science concepts. High mental ability students' had highest attitude mean score ($\bar{x}$ = 51.89) than low mental ability ($\bar{x}$ = 48.79) and medium mental ability ($\bar{x}$ = 48.16) students'. Self-Concept had significant effect on students' achievement in Basic Science ($F_{(2, 204)}$ = 4.261; P < .05). Students having low self-concept had higher attitude mean score ($\bar{x}$ = 50.20) than those with high self-concept ($\bar{x}$ = 49.18). A significant interaction effect existed between teaching strategies and mental ability on students attitude towards Basic Science concepts ($F_{(4, 204)}$ = 2.423; P < .05). The Conventional strategy favoured low and high mental ability students on attitude towards Basic Science concepts than the Cognitive Coaching and Simplex strategies. The medium mental ability students' had better attitude towards Basic Science concepts with Cognitive Coaching strategy being better than their counterparts in other groups.

Simplex and Cognitive Coaching strategies were effective in caausing conceptual change and improving students' learning outcomes in Basic Science. Basic Science teachers should therefore, use Simplex and Cognitive Coaching strategies for enhancing students' learning outcomes in Basice Science while also considering the possible additional effects of self-concept and mental ability.

Key words: Simplex Strategy, Cognitive Coaching, Mental Ability, Self-Concept, Basic Science.

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DEDICATION

This Thesis is dedicated to my late mother

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who passed on to Eternal Glory at the inception of this academic pursuit,

remain at the bosom of the Lord gloriously.

CERTIFICATION

I certify that this work was carried out by Gbemiga Jacob Arowolo in the Department of Teacher Education, Faculty of Education, University of Ibadan, Ibadan, Nigeria.

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SUPERVISOR
DR. (MRS) TEMISAN A. IGE
Ph.D. M.Ed. (Ibadan) B.Ed. (Benin)
Science Education
Department of Teacher Education
University of Ibadan, Ibadan, Nigeria.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the problem

One of the major purposes of science education has been to expose students to the means of developing scientific knowledge that would be personally plausible and applicable to real-life challenges. This science in focus covers the broad field of knowledge that deals with observed facts and relationships among those facts. Eylon and Linn (1988) cited by Keselman, Kaufmanm, Kramer and Patel (2006) submitted that the application of classroom learning to real-life issues is a challenge, as students often cannot transfer known facts to novel situations either during written examination or in practical terms. Keselman et al, (2006) further reported that intuitive beliefs that students develop on their own from their cultural background before taking science courses have a special place among the sources of difficulties they come across. It is known that in whatever field scientists work, they explore the workings of the world using systematic methods of study to make observations and collect facts. Scientific theories consist of general principles or laws that attempt to explain how and why something happens or happened. Science therefore advances as scientists accumulate more detailed facts and gain a better understanding of these fundamental principles and laws that govern the universe. For any knowledge to be truly scientific, it must be repeatedly tested experimentally and found to be true. This characteristic of science sets it apart from other branches of knowledge as scientific progress depends on the expansion of new ideas or replacement of old ones. Thus, the theories of modern scientists have revised many ideas held by earlier scientists. Repeated observations and experiments lead scientists to update existing theories and to propose new ones. This leads to the growth and improvement of scientific knowledge. Science as a body of knowledge has enormous influence on human lives. It provides the basis of much of modern technology – the tools, materials, techniques, and sources of power that make our lives and work easier. Today, modern science and technology have changed our lives in many dramatic ways. Science has greatly affected the way we view ourselves and the world around us (Falk and Dierking, 2000). In ancient times, most people believed that natural events and everything that happened to them resulted from the actions of gods and evil spirits. For example, they thought that angry gods and evil spirits caused disease by invading or attacking the body. The ancient Greeks were among the first people to begin to use systematic observation and reasoning to analyse natural happenings. Hence, as scientific thinking gradually developed, nature came to be seen less and less as the product of mysterious spiritual forces. Instead, people began to feel that nature could be understood and even controlled through science.

In the aftermath of World War I and the vast, often destructive, changes to European civilization that resulted, the ideal of cumulative, progressive scientific knowledge became a totem held by post war society. Hence, science was viewed as the only truly cumulative human activity, particularly in the light of the capacity for events such as war to damage or destroy past evidence of civilized achievement. It implies that science is a systematized progressive knowledge, or what has been taken as such at different ages and in different places (Davis, 2001). The mission and vision of cumulative and progressive science was shattered however, as Kuhn (1996) envisioned periods of so called normal science, during which work within a discipline proceeds according to certain research traditions, leading to the accumulation of facts and theories that correspond to accepted lines of thought. He asserts that the influence of particular values may at first be external to the scientific community, with social needs and values ultimately pushing certain questions to the forefront of scientific research. As a field of science develops, internal traditions replace external societal concerns, as research in the discipline comes to be based on a paradigm. Kuhn defined a paradigm as a set of generally accepted solutions to central problems within a science, and he believed that the paradigm provides a model for the consideration and solution of other problems relating to that field. The use of paradigm, to Kuhn is based on the training and subjective values of scientists, rather than on critical experimentation. Eventually the idea of a scientific paradigm took on a wider meaning than he had intended, so that the term now refers to the entire constellation of beliefs, values, and techniques that bind together a scientific community. In time normal science may produce an anomaly, a new and unexpected phenomenon. Most anomalies are resolved in the terms of the paradigm, but those that are not can lead to a crisis, accompanied by large scale paradigm destruction, a breakdown of normal science, and a proliferation of new and competing theories. Crisis leads to scientific revolution, a non-cumulative, developmental episode in which an older paradigm is replaced with an incompatible new paradigm.

Here in Nigeria, science learning had passed through series of modifications in the curriculum in the 1960s and 1970s from rural science, hygiene, elementary science or nature study to general science. The detailed objectives of these modifications were meant to lead Nigerian students to the acquisition of scientific skills and equip them with the ability to solve everyday problems as they arose. This effort was supposed to a laudable strive to global demand by National standard and goals for reforming science education for more academic regour in the teaching and learning of complex subject matter (American Association for the Advancement of Science (AAAS), 1993; National Research Council (NRC) of America, 2000). As the struggles to comply with the stated vision and mission of the Federal Government of Nigeria became vital, the Science Teachers' Association of Nigeria (STAN) reviewed the science curriculum between mid-1968 and mid-1970. The aim was to consider both the changing needs of Nigerian pupils and international trends in their respective disciplines as well as to prepare detailed guidelines for future science teaching. The result of this effort is embodied in STAN's Newsletter No 1 on an Integrated Science course which contains guidelines for effecting the course for the then junior forms of secondary school. The financial support came through Comparative Education Study and Adaptation Centre (CESAC) – University of Lagos as well as Curriculum Renewal and Educational Development Overseas Organization (CREDO) – United Kingdom. The major writing effort of the Nigerian Integrated Science course took place at the conference center, University of Ibadan in September, 1970. STAN thus offered to schools and colleges a set of materials for a two-year course comprising pupils' textbooks, workbooks and teachers' guides. By 1972, the first edition of the Nigerian Integrated Science Project (NISP) was published. With the approval of a new Nigerian National Policy on Education by the Federal Government of Nigeria involving a six-year, two-tier secondary educational programme a decade later, a review of the NISP to fit into the new three-year junior secondary school took place. The Federal Ministry of Education (FME, 1981) thus made use of the old edition of the NISP as a pivot for the new three-year edition published in 1982 with the adoption of a six-unit approach to content organization (Appendix XIa). The vision and mission though, stressed that science education shall cultivate inquiring, knowing and rational mind for the conduct of a good life and democracy [section 7: 39 (b) (i)], and the policy contains contents and materials relevant to the students' experience, the need for science to be presented as a "whole" to learners became imperative. The basis for integrating concepts from a variety of core and applied sciences in the form of Integrated science which was offered as a subject in the secondary school was therefore established. This Integrated science also passed through series of reforms embarked upon by Nigerian Educational Research Development Council (NERDC, 2007) as the curriculum in which it was contained could no longer reveal the aims of preparing students for more advanced science studies. The subject was thus re-aligned and restructured considering issues on globalization, information and communication technology and entrepreneurship education by infusing relevant contents in every class and renamed Basic Science. This new curriculum that adopted a four-theme approach to content organization is used to cover knowledge, skills and attitudinal requirements (Appendix XIb). Although, the relevance of this subject in the development of science and technology as ascertained and stated in the National Policy on Education (NPE) by the Federal Ministry of Education (FME, 1981; NERDC, 2004) are to include: to produce scientists for national development, provide service studies in technology and the cause of technical development, etc, these yearnings are yet to be met as students achievement in the subject is on the decline. Despite the fact that it was purposively made a core subject as the only science subject offered by students in the first three years of secondary education in Nigeria with the aim of providing primary school learners with the opportunity of acquiring technical knowledge and vocational skills necessary for agricultural, industrial and economic development, this effort had yielded little impact. The Kwara State Government delayed the implementation of the new curriculum due to unavailability of instructional materials for teaching the new contents as well as the state government's policy to first expose teachers to professional development programmes that would facilitate the implementation of the new curriculum. The high demand for science by all nations implies that science is a procedure for answering questions, solving problems and developing more effective procedure for answering questions and solving problems. It has being argued thus that common sense inquiry 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 quantitative"(p 65).* 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 which is referred to as scientific inquiry. This scientific inquiry derives from the fact that it is controlled. A process is controlled to the extent that it is effectively directed toward the attainment of desired objectives.

The goals for scientific inquiry in Nigeria as indicated in the National Policy on Education reflect among others the acquisition of appropriate skills and the development of mental, physical and social abilities and competencies as basic requirements for the individual to live in and contribute to the development of the society. Educational activities therefore are expected to be centered on the learner for maximum self-development and self-fulfillment [section 1:7 (d); 9 (d)]. In view of these, the junior secondary school is made both pre-vocational and academic. This level is expected to teach basic subjects (Basic Science inclusive) which will enable students' to acquire further knowledge about nature and skills to address life challenges.

The learning of Basic Science concepts was meant to follow constructivist principles which basically promote active learning. From this perspective, learning is viewed as a generative process requiring efforts in which learners actively construct their own meaning (Osborn and Wittrock, 1983, 1985). Learning occurs through interactions with the physical world and is mediated by socio-cultural interactions with the ecological system (friends, family, teachers and other human species) in the society. All of these are filtered through the lens of prior knowledge and experience from home and primary school (Falk and Dierking, 1992, 2000). The creation of new understanding and attitudes depend on the successful integration of the learner's prior-experience afforded by the physical and socio-cultural context of the ecological system.

Basic Science brings together as a whole, fundamental concepts of all the sciences in the area of life, energy, and environment. All the conglomerated concepts from these areas of specialization are germane to providing learners at the junior secondary school level with the functional knowledge and skills required to meet the aspirations of the society. The need to achieve the goals of teaching and learning Basic Science has been documented by the Nigerian Educational Research and Development Council (NERDC, 2004) in the National Policy on Education to include: producing scientists for national development; service studies in technology and the cause of technological development as well as provide knowledge and understanding of the complexity of the physical world, the forms and the conduct of life [section 7:

39 (b)]. Though, science educators though often focus on the ideas that they want their learners to have, research findings however, have shown that a learner's prior knowledge often confounds an educator's best efforts to deliver ideas exactly well (Strike and Posner, 1985; West and Pines, 1985; Lewis, 1991; Roschelle, 1994). Considering a hypothetical book on wool production in Australia for instance, Australia ranchers raise sheep in an extremely hot desert climate. The sheep are raised to have wool so thick that without yearly trimmings the sheep would be unable to walk. These facts of raising thick coated sheep within the hot desert are absurd to the students as Lewis (1991) opined that children think wool is hot; if you put a thermometer inside a wool sweater, the mercury would rise up. To the child who has not yet understood heat and temperature, no quick explanation can possibly resolve the contradiction between the hot desert and the warm wool; it took weeks to years for this understanding to emerge (Lewis, 1991). Many other findings show that learning proceeds basically from prior knowledge, and only partly from the teaching materials. Prior knowledge thus determines what an individual learns from experience and also compels a theoretical shift to viewing learning as "conceptual change", (Strike and Posner, 1985; West and Pines, 1985). Findings have also provided evidence that conceptual understanding mediates reasoning and problem solving (Chi and Roscoe, 2002). In the same vein, Chi, Feltovich and Glaser (1981) had earlier submitted that the structure of one's knowledge can be effectively applied to problem situation. Although, learning is a process of accumulating information or experience, prior knowledge is the bane of transmission-absorption models of learning which propose that students' ideas can be both "fundamentally flawed" and "a means for constructing knowledge" (Lewis, 1991). However, mere absorption cannot

justify the revolutionary changes in thought that must occur. The learners cannot simply absorb knowledge about wool, because prior knowledge about heat ("put on your warm clothes", which parents and teachers had told them) renders incoming ideas nonsensical. On the other hand, it is impossible to ignore prior knowledge if learning must occur. Eliminating prior understanding of heat will not explain why the sweater is all the more so nice in the winter, or how thick coated sheep can be raised in the desert. The idea of decentralized principles must be built from some anchor in prior experience. There is widespread agreement that prior knowledge influences learning, and that learners construct concepts from prior knowledge (Resnick, 1983; Glaserfeld, 1984), yet, there is much debate on how to use this fact to improve learning.

It is on this premise that Nigerian science educators need to pay attention to the key ideas in constructivism which holds that we "create experiences that engage learners' in actively making sense of concepts for themselves". This is necessary because children enter elementary school with substantially contradictory knowledge constructions or explanatory conceptual frameworks about physical world (Vosniadou, 1999). For instance, when students were prompted to explain certain phenomena in Basic Science, most students explanation about thunder was much embarrassing. Some felt, it was a god roaring with deep rumbling or sharp crackle or loud crashing noise to threaten humans and about to avenge or attack human misdeeds. This is contrary to how scientists perceive thunder which results from the violent expansion of air that has been heated by lightning and the collision of the flying air particles. Further, student's knowledge constructions frequently are at odds with scientifically accepted norms (Palmer, 2001; Trend 2001) as it was also documented that student's knowledge of rainbow indicated that, it was a python that used to drink water or lay eggs each time it forms in the sky. This is again incongruent with scientific explanation that connects rainbow formation to internal reflection and refraction of light rays from the sun onto droplets of rain water in the atmosphere. In like manner, when students were asked to explain how water gets into coconut, it was surprising to hear them say that nobody can understand how water gets in, rather, it is a command by God that water should be inside the fruit. This is also at variance with how biologists would link the means through which water gets into coconut to osmosis. Because nonscientific, or alternative conceptions that students bring to a variety of instructional settings are frequently internally coherent and robust (Vosniadou, 1999), it is not surprising that they are persistent and difficult to change (Trundle, Atwood and Christopher, 2007). Since the existence of cultural knowledge may be in conflict with the learning process, constructivism stresses the need to suppress, eradicate or overcome its influence. Roschelle (1994) reflecting on Piaget's ideology, emphasizes changes in the structure of prior knowledge and maintains that the theory concerns the development of schema in relation to new experience. Children like adults, combine prior schemata with experience. However, children's notions of space and time qualitatively differ from adults (Piaget, 1970). Piaget provides a theory of conceptual change that focuses on the development of schemata from childhood to maturity. He provides a characterization of children's knowledge at four stages of maturity, termed sensorimotor, preoperational, concrete operation, and formal operation (Corsini, 1994). At each successive stage, more encompassing structures become available to children to make sense of experience. In his account of conceptual change, knowledge grows by reformulation. He identifies a set of invariant change functions, which are innate, universal, and age independent to include: assimilation, accommodation and equilibration. Assimilation increases knowledge while preserving that of structure, by integrating information into existing schema. Accommodation increases knowledge by modifying structure to account for new experience. Equilibration coordinates assimilation and accommodation, allowing the learner to craft a new, more coherent balance between schemata and sensory evidence. Reformulation does not replace prior knowledge; rather, it differentiates and integrates prior knowledge into a more coherent whole. It can be gathered from his theory and methods that educators can create tasks that engage learners' and create tension between assimilation and accommodation. Thus, engagement in physical aspects of a challenging task can lead to reformulation of intellectual development in terms of four stages (Karplus, 2003). The first two stages, called sensorimotor and preoperational, are usually completed when a child is seven or eight years old. Following these are the other two stages of logical operations called concrete thought and formal thought, which are relevant to secondary school students. Piaget has ascribed the process whereby individuals advance from one stage to the next to four contributing factors: maturation, experience with the physical environment, social transmission and "equilibration". The last item designates an internal mental process in which new experiences are combined with prior experiences to generate new logical operations. The description of the stages as proposed by Piaget indicates the mental operations the learners use when confronted with other uses of the term 'operation' in science, it is therefore useful to employ the phrase "reasoning patterns". Two examples of behaviours based on reasoning patterns as identified by diSessa (1993) are:

(a) Serial ordering of a set of sticks according to their length and

(b) Investigating the effect of fertilizer on maize plants by setting up several test plantings that are treated alike in all respect except in the amount of fertilizer applied to them.

From the research of Piaget and others, certain rules could have been formulated for identifying reasoning patterns as belonging to concrete or to formal thought. In general, reasoning that makes use of direct experience, concrete objects, and familiar actions is classified as a concrete reasoning patterns, such as example 'a' above. Reasoning that is based on abstractions and that transcends experience is classified as a formal reasoning pattern, such as example 'b' above.

Though, Piaget develops a theory of the growth of structuring schemata, Roschelle (1994), observed that Dewey (1938) elaborated the experiential side of learning. In Dewey's account of learning, problematic experience comes to the fore in a way that primordial experience occurs in a physical and social situation. Learners experience is considered an active transaction that coordinates doing and undergoing. These experiential transactions have simple qualities that we can directly apprehend such as: they can be joyful, frightening, tasty, or harmonious. Since in most of life endeavours, we proceed smoothly from one transaction to the next, using and enjoying the objects of our experience, the experience could sometimes have the quality of being problematic (Roschelle, 1994). This means from Dewey's point of view that we feel confused, uncertain, incoherent, and unable to act. We are unable to coordinate prior knowledge and prior habit to cope with the exigencies of the moment. In the situation of problematic experience, we can engage a different mode of life from use and enjoying, which Dewey calls inquiry. Inquiry as felt by Dewey is the reflective transformation of perception, thought and action that re-unifies experience into a more satisfactory whole. The process of inquiry it is believed, involves reflection on experience; we thus apply tools like concepts, drawings, and gestures to point to features of experience that are troublesome. At the same time, we apply tools to project possible solutions. Through experiment and reflection, both schemata and perception are slowly transformed to bring coherence, coordination and meaning to our transactions. This idea thus stresses the conditions that enable inquiry to resolve problematic experience. This directs educators to discover what is problematic for the learners, then, establish conditions that support the process of inquiry such as time, tools and talk.

The role of social interaction in this learning process in enhancing students' learning outcomes has been shown to be significant. That was why Vygotsky (1986), among others, maintained a stand on the role of social process in learning, suggesting that new concepts appear socially first, before gradually becoming psychological. He recommends that educators should provide social models of appropriate activity that enable groups of learners to do more complex activities than they could handle individually, and use signs to enable people to negotiate the different meanings they find in social activity. Also, findings have shown that, for meaningful learning to take place there must be an interaction between learner's previous knowledge and the new materials to be learned (Olagunju, Adesoji, Ireogbu and Ige, 2003) corroborating Ausubel (1968) submission.

There is general agreement (Nelson, 1977; Novak, 1977; Driver and Easley, 1978; Resnick, 1981), that a significant characteristic of a person's knowledge is its structure defined by the units of information as well as the way in which they are linked together and used. In this study, these structures are referred to as "conceptions" and the prior knowledge of students is regarded as "traditional or local conceptions". Research findings on conceptual understanding held by students have shown that there can be significant differences in students' conceptions of the same phenomenon (Roschelle, 1994). This prompted the interest of some researchers to the careful documentation of common misconceptions made by students in solving physics and Mathematics problems. For instance, as observed by diSessa (1993), when students were asked by Physics teachers to explain a toss of a ball straight up in the air, they described the motion in terms of an "initial upwards force" which slowly "dies out", until it is "balanced" by gravity at the top of the trajectory. Physicists on the contrary, explain the ball toss in terms of a single constant force, which is gravity that gradually changes the momentum of the ball: on its way upwards, the momentum is positive and decreasing; at the top, it is zero; and going down, the momentum is negative and increasing. From analysis of students thinking, researchers have determined that this "mistaken" explanation is not peculiar to this problem. Students commonly give explanations in terms of "imparting force", "dying out", and "balancing" (diSessa, 1993). From these commonsense ideas, students can generate endless explanations for different situations which disagree with conventional Newtonian theory. Other findings reveal that the misconceptions are not random slips but rather derived from understanding concepts. Most studies that looked at the roles of prior knowledge in a conventional science course report that the results depend on the nature of the task used to probe students' learning. If the task is procedural calculation, students can often learn to get the right answer independent of their prior knowledge. However, if the task requires students' to make a prediction, give a qualitative explanation, or otherwise express their understanding, students' show that their prior knowledge "interferes". diSessa (1982) on the one hand found that students who were receiving an "A" grade in a freshman Physics test could not explain the simple ball toss problem correctly. Using their prior knowledge, students often construct idiosyncratic, nonconforming understanding of the scientific concepts. Halhoun and Hestenes (1985a, 1985b) from another end found that 30% to 40% of Physics students who pass freshman Physics test at various Universities misunderstood the concepts. They stress further that this has been found at the secondary school level across both western and non-western cultures around the world culminating into feeling that about that 30% to 40% of Physics teachers at the secondary school level also misunderstood Physics concepts because of their prior knowledge.

The process by which "misconceptions" arise from a combination of prior knowledge and instructed subject matter are not unique to Newtonian mechanics. More significantly, students often hold "alternative conceptions" which are at variance with the significantly acceptable conceptions, even after formal instruction. Students have concepts that differ from scientists viewpoints and encounter difficulties as they interpret the scientific theories in the particulate nature of matter (Nussbaum and Novick, 1978), dynamics (Viennot, 1979; Caramazza, McCloskey and Green, 1981), kinematics (Trowbridge and McDermott, 1980), wide range of concepts in general science (Gilbert and Osborne, 1980), heat and temperature (Erickson, 1980; Lewis, 1991), electricity (Gentner and Gentner, 1983), biology (Carey, 1985); Mathematics (vanLehn, 1989), and computer programming (Spohrer, Soloway and Pope, 1989).

It is expected that the teaching of Basic Science would result in the acquisition of fundamental scientific knowledge, skills and attitudes necessary to solve everyday problems. It is equally necessary that there is manifestation of conceptual retention of the knowledge gained over a period of time. Though, there is the tendency for the Basic science teacher to be anxious that the students should learn as fast as possible, than to ensure that learning is effectively retained, yet there is need for learning to be lasting. Basic science learning can be useful only when it is more or less permanent. It cannot be expected of course, that learning should be completely permanent. Something of what has been learned will be forgotten, no doubt, but it is possible to achieve permanence in some degree. One of the criteria of the effectiveness of Basic Science learning is its relative permanence. It is expected also that the junior secondary school students would be able to use what they have learnt a long time after they have acquired the experience. This is especially necessary for tackling their end of junior secondary examination. After learning has ceased, the process of forgetting begins. In some situations after learning has ceased, most of it is soon forgotten. In other cases the rate of forgetting is slower. After sometime what the students' are able to retain remains with them. Forgetting and retention are two aspects of the same phenomenon. Retention is the persistence of learning after the learning has ceased and is shown in its recall in a situation similar to the one in which it had occurred (Kuppuswany, 2007). Forgetting increases with lapse of time, or in other words, retention diminishes with time. Retention of main importance in the context of this study is memory. Kuppuswany (2007) identifies the phenomenon of memory to be of four aspects as: learning, retention, recall and recognition. In fact retention takes the form of memory. Recall and recognition are the function of retention. Retention is known through recall and recognition of materials learned – names, numbers, facts, words, etc. Retention can be measured in various ways through: method of recall; method of relearning; method of reconstruction, and method of recognition. Equipped with this information could enable teachers and students' intensify effort at improving on Basic Science conceptual retention.

Regrettably, the annual performance of students in Integrated Science (structured to Basic Science) shows a decline in achievement in Kwara State, for example, statistics for the junior secondary school level obtained from the Test, Examination and Measurement Unit of the State Ministry of Education indicates that from 2001 to 2010, students performed well in 2003* and averagely in 2005* and 2010* in Basic science. The students' performance for the remaining years (ie, 2001, 2002, 2004, 2006, 2007, 2008 and 2009) in the subject was below 50% as shown in table 1.1.

Table 1.1: Trend Analysis of JSCE Integrated Science Results (2001-2010)

Year	Students population	Grade								% Credit & above
		Excellent (A)		Credit (C)		Pass (P)		Failed (F)		
		N	%	N	%	N	%	N	%	
2001	21304	179	0.84	1746	8.20	15007	70.44	4322	20.29	9.04
2002	24116	4063	16.85	7092	29.41	8330	54.54	4631	19.20	46.26
2003	26941	9164	34.02	10023	37.20	5036	22.03	1828	6.79	71.22*
2004	29092	498	1.71	2846	9.78	22612	77.73	3136	10.78	11.49
2005	35417	5385	15.20	12406	35.03	14453	40.81	3119	8.81	50.23*
2006	37321	4123	11,05	9412	25.22	13920	37.30	10668	28.58	36.27
2007	42071	7601	15.93	12001	28.53	13910	33.06	9459	22.48	44.46
2008	49741	3414	6.86	14921	30.00	17908	36.00	13461	27.06	36.86
2009	57783	8760	15.16	17849	30.89	26035	45.06	5139	8.89	46.05
2010	60902	7959	13.07	23003	37.77	21927	36.00	8013	13.16	50.84*

Source: Kwara State Ministry of Education Annex Ilorin (2011).

The Reasons for low state of students learning outcomes in science subjects over the years have been identified from research findings to include: teacher's poor attitude towards science teaching (Ogunbiyi, 1981; Okpala, 1985; Onocha, 1985), poor method of teaching (Ojo, 1989; Osuafor, 1999), poor science background of students (Bello, 1995; Osokoya, 1998; Adesoji, 1999) and laboratory inadequacy (Raimi, 2002; Adeyegbe, 2005) among others. The below average achievement as revealed on the table for seven years out of the ten years considered sends signals that the state was yet to measure up to the standard expected of a nation that could be in-charge of its own scientific and technological endeavours.

As revealed in table 1.1, a large percentage of Basic Science students' in Kwara State may not have the opportunity to study science related courses further in the senior classes, since at least a credit pass is the minimum requirement. Other reasons that may be responsible for poor achievement in the subject could range from students poor conception of scientific phenomena, mental ability, cultural background, school environment, teaching methods, teacher's/students' attitude, resources available for teaching, breakdown in the school calendar due to strike action, among others. All these can, no doubt, have a negative effect on learning environment necessary for students to acquire and build upon genuine scientific experience (Ogunbiyi, 1981; Odubunmi, 1986; Davis, 2001; Douglas, 2007).

The performance of students in any academic work was included as a separate category to assess how students orchestrated their process skills and developed science concepts, prior experiences and tacit knowledge (Cheung and Taylor, 1991). This was to avoid the decontextualisation of process skills from the problem context and a reductionists or atomistic view of scientific inquiry. The aim was to initiate students into scientists' codified ways of doing science and to develop habits of applying or reworking key scientific ideas in everyday lives. Thus, the inclusion of Basic Science as a core subject in the junior secondary school curriculum calls for a need to teach and learn it effectively. The research work on the assessment of performance unit throughout the early 1980s in the United Kingdom regarded students as problem-solving scientists, who should be actively inquiring, speculating, constructing, and testing knowledge in personally relevant and meaningful contexts (Cheung and Taylor, 1991). Their work placed emphasis on illustrating the close interplay between science concepts and methods as well as in knowledge acquisition and production. Among the variables that educational psychologists have found to be important in classroom teaching include the 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 behaviour, and create a warm and democratic atmosphere for learning (Gould, 1981). The teaching and learning of Basic Science depend 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 scientific experiences. Many researchers have espoused the position of Ausubel's (1968) well known maxim: *The most important single factor influencing learning is what the learner already knows. The teacher should therefore ascertain this and teach him accordingly (p vi).*

Scientific conceptions are commonly used to denote a sphere of human activity characterized by special qualities such as: rationality, precision, formality, detachment and objectivity. Therefore special conceptions may be held by scientists. The alternative or local conception is commonly linked to another, opposing set of qualities: improvisation, ambiguity, informality, engagement and subjectivity. The presumed differences between scientific and traditional conceptions are often framed as sets of dichotomies, with the left-hand term in the pair being the privileged scientific one; the one seen as representing a cognitive ideal: precise versus imprecise language, logical versus analogical reasoning, skepticism versus respect for authority and so forth. But what is the status of these dichotomies as descriptions of human experience? Within the field of science education, different traditions have emerged that revolve around the examination of the relationship between traditional conception and scientific knowledge and knowing (Warren, Pothier, Ogonowski, Noble and Goldstein, 2000). In one tradition, the relationship is viewed as descriptive of differences in the knowledge, knowing and language use characteristic of ordinary people and of scientists. In a second tradition, the dichotomy gives way to an articulation of dimensions of continuity between ordinary people and expert scientists. Each of these views is at bottom concerned with understanding how students learn Science and how best to teach the subject.

Recent studies of cultural congruence catalogue what the authors described as the incongruence between the habits of mind and language and other interaction practices of students from certain language minority groups and those valued in national science standards. They suggest further that these habits of mind and interaction practices may impede students' learning in science (Lee and Fradd, 1996) as in the following:

In teacher-student interactions, both teachers and students from diverse backgrounds bring with them ways of looking at the world representative of the environment in which they have been reared. These habits of mind or way of knowing may or may not be compatible with scientific habits of mind or ways of knowing typically associated with scientific discourse… interaction patterns within a language and culture group may be incompatible with scientific practices as taught in the mainstream. For instance, the nature and practice of science involves the use of empirical standards, logical arguments, skepticism, questioning, criticism and rules of evidence. These practices may be incongruent with cultural interactions that favour cooperation, social and emotional support, consensus building and respect for authority. Scientific practices that encourage support, creative and independent thinking may also be incongruent with cultural interactions in which information is given to learners by authority be it a teacher or a textbook (Lee and Fradd, 1996: 247).

In this view, differences in the social, cognitive and linguistic practices of particular linguistic or ethnic minority groups from those of the "mainstream" are conceptualized as potential barriers to students' learning and achievement in Science. It is argued in particular that whereas teachers may be successful in supporting these students' engagement by establishing culturally congruent ways of participating in school Basic Science and Technology, such as through respect for authority or with emotional support, such classroom norms may in fact be "inconsistent with the norms of discourse and task engagement in science" as outlined in National Science Education Standards (Lee and Fradd, 1996).

A second tradition of inquiry in Basic Science takes a different view. It focuses on understanding the productive, conceptual, meta-representational, linguistic, experiential and epistemological resources students have for advancing their understanding of scientific ideas (Clement, Brown and Zeitsman, 1989; Lehrer and Schauble, 1989; Minstrell, 1989; diSessa, Hammer, Shrin and Kolpakowski, 1991; Smith, diSessa and Roschelle, 1993; diSessa, 1993; Nemirovsky, Tierney and Wright, 1998; Hammer, 2000). This work does not assume a simple isomorphism between what students' do and what scientists do; rather, it views the relationship as complex and taking a variety of forms; similarity, difference, complementarities and generalization.

In addition, students' most particularly disadvantaged by strategies based in a dichotomous view are those whose everyday ways of knowing and talking are seen as being farthest from those traditionally valued in school science or even in national standards. Recent research concerned with this issue has documented the various ways in which poor and minority students' ideas and ways of talking and knowing are related to those characteristic of scientific communities (Warren and Rosebery, 1996; Rosebery and Warren, 1999; Ballenger, 1997, 2000; Warren, Pothier, Ogonowski, Noble and Goldstein, 2000; Michaels and Sohmer, 2000).

These findings are buttressed by recent researches in history and social studies of science, which have described the intricacies of intertwining conceptual, imaginative, material, discursive and experiential resources in scientists work (Fox-Keller, 1983; Lynch, 1985; Latour and Wootgar, 1986; Jacob, 1987, 1995; Gooding, Pinch and Schalter, 1989; Root-Bernstein, 1989; Ochs, Jacoby and Gonzales, 1996; Godwin, 1997; Rheinberger, 1997; Biagioli, 1999). These studies, in their detailed analysis of everyday work and talk of scientists, espoused a greatly expanded view of scientific practice, one which goes beyond emphasis on hypothetico-deductive reasoning and theory-building, everyday experience as a form of misconception and informal language as inadequate to the task of precise description, explanation and modeling.

Learning is at the center of human ability to adapt to the most trivial and the most profound environmental demands. It makes the difference between purposeful action and directionless activity. Indeed, it is the crucial process necessary for knowing a world rich with experience and opportunity. Afuwape (2004) stressed the use of suitable control strategy or strategies to facilitate creativity in learners in Integrated Science. Scott, Asoko and Driver (1991), considered teaching strategies that work, and noted two successful strategies, one that rests on explicitly working to resolve conflicts and another which builds on correcting prior knowledge. When appropriate care is taken in acknowledging learners ideas, they can succeed in conceptual change. This further envelops them in an appropriate discourse and provides ample support for the cognitive struggles that may come into play. This overwhelming weight of the evidence is thus enough to compel informed educators to fundamentally change the way Basic Science is taught. It implies that the effects of prior knowledge require a change from the view that learning is absorption of transmitted knowledge, to the view that learning is conceptual change (Resnick, 1983; Champagne, Gunstone and Klopfer, 1985). Over time, learners need to accomplish the rarest form of change, a paradigm shift in their basic assumptions about the natural world, and the accompanying ways they see, conceive and talk about the world. Conceptual change is a process of transmission from ordinary ways of perceiving, directing attention, conceptualizing, reasoning, and justifying as Posner, Strike, Hewson and Gertzog (1982) observed that slow learners transform prior knowledge to accommodate new scientific ideas.

Since late 1970s, the notion of ‘conceptual change” has been a pedagogical football among science educators (Roschelle, 1994). It is argued further that reading and observing scientific principles will not alone move the mountain of “alternative frameworks” about science that students bring to the classroom, and that even hands-on activities allow such thinking to go undetected. Teachers are beginning from the scratch to helping students construct their own models of scientific principles (Roschelle, 1994). If students base their thinking on what they have seen and felt, then their experience must be structured to challenge their erroneous beliefs. If alternative views of scientific principles are not addressed, they can coexist with “what the teacher told us” and create a miss mash of fact and fiction. But if each student is given a chance to test his or her own model of a given phenomenon and find its limits, then a deeper understanding without the naive conceptions could result.

In view of the conflicting influence of prior knowledge which in one way or the other may affect the students learning outcomes (Keselman et al, 2006) in Basic Science, there is a need for a shift in intervention from routine methods to suitable pedagogies which can lead students to understand and acquire scientific conceptions. Such pedagogies which explore students’ prior knowledge could also facilitate conceptual change as well as enhance conceptual retention for learners. This study used Simplex and Cognitive Coaching as viable strategies to achieve this.

Simplex is a powerful conceptual change and industrial-strength creativity tool that enables students “do science” at the level of latest improvements and refinements. Rather than seeing creativity as a single straight-line process, Simplex sees it as the continuous cycle it should be. The completion and implementation of one cycle of creativity leads straight into the next cycle of creative improvement. The process is an eight-stage cycle. Upon completion of the eight stages, it is started all over again to investigate another concept. Simplex method as discovered by Danzig (1947) and developed by Basadur (1994) is a "complete" process of creative conceptual change strategy with three steps (picking topics, defining concepts, implementing conceptions) and eight discrete stages. The process provides a framework for using various tools. Simplex resembles a wheel (fig: 1.1) to reflect the circular, perennial nature of conceptual change. The stages in the process are:

Topic finding,

Fact finding,

Concept Definition,

Idea Finding,

Selection and Evaluation,

Action planning,

Gaining acceptance,

Taking action.

By moving through these stages, one ensures that one understands the most significant concepts with the best solutions available to him or her.

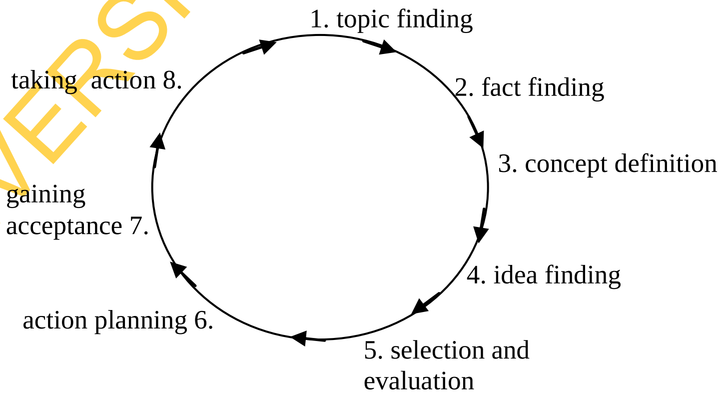

Fig 1.1 Simplex continuous cycle process
(Adapted from Mind Tools Excellent Career Club, 2008)

In practical terms, the expectations of the users of Simplex strategy at each stage are as explained below.

Topic finding: when using simplex strategy, actively picking a topic is necessary. The topics may be obvious, or can be flushed out using trigger questions like: what information does the students need to improve upon individually?; what could the students do better if teachers help them?; what difficulties do students encounter in understanding the topic?; how can the quality of understanding the topic be improved?, and what resources are available for students to work with? These questions deal with the topic(s) that exist in the syllabus. At this stage, it is useful to try to look into the future benefit of treating such topic(s). There is need to think about how the students will develop over the next few years; the obstacles experienced as the students' population increases as well as various other changes that may come to affect the learning of the topic.

Fact finding: this is the stage that involves sourcing for as much information relating to the topic as possible. This will help to give the depth of knowledge needed to: use the best ideas that other students have had; understand societal needs in more detail; know what has already been tried; fully understand any processes that are needed to be used, and ensuring that the objectives of learning the topic will be worth the effort put into it.

Concept definition: at this stage, one should know roughly what the concept about the topic is, and should have a good understanding of the facts relating to it. This involves breaking the concept down into its component parts.

Idea finding: this is where many ideas are generated as much as possible about the concept. This is done by asking the students to state their opinions, through programmed creativity tools and lateral techniques to brainstorming.

Selection and evaluation: as many ideas are available about a concept, then it is necessary to select the most appropriate one. This involves thinking through the criteria to be used to select the best idea (that is, making a decision). The selected concept is then developed fully. This leads into evaluating the developed concept to be sure that one is actually moving or working towards achieving the objectives.

Planning: once an idea has been selected and there is assurance that it is worthwhile, then a plan for its implementation follows. This entails setting out an action plan which lays out who, what, when, where, why and how of making it work or verifying the scientific concept.

Acceptance: this stage requires that each student or group of students display their ideas to other members of the class. This is done verbally or written, by drawing or measuring or calculating, etc.

Action: this is the stage that compels each student to carry out a follow-up activity based on the concept learnt by returning to stage one and moving through other stages to the end.

The skills required for use by participants when Simplex strategy is employed are:

Divergence:- the ability to imaginatively list facts, ideas, solution without evaluation, judgment or criticism.

Convergence:- the skill as individuals and as a group to select the most important, insightful facts, idea or solution using judgment and evaluation.

Deferral of judgment:- the ability to consciously separate the two steps.

Potworowski, Felio and Palmer, (2008) reported that Simplex provides opportunities for change and ensures continuous improvement where misconceptions do exist; it is suitable for projects and organizations of almost any scale, and that the process can help individual to be intensely creative.

Cognitive Coaching is based on the idea that meta-cognition, ie, being aware of one's own thinking processes, fosters independence in learning. It involves the modeling of self-appraisal and the self-management of cognition by an expert. It also involves learner performance and reflection, internalizing, and generalizing. Cognitive Coaching process as founded by Costa and Garmston (1994) involves the initiation of verbal rapport, expression of views, reading, reflecting and listing of main ideas about a concept as well as seeking clarification and accommodation of new ideas. It enables people to modify their capacity to modify themselves. The metaphor of a stage coach is one used to understand what a coach (ie teacher) does - convey a valued person from where the individual is to where such individual wants to be. It is based on the assumptions that the use of Cognitive Coaching reveals that: perception and thought produce most behaviour; teaching is constant decision-making; to learn something new requires engagement and alteration in thought, and humans continue to grow cognitively.

A coach (teacher) is actually a mediator, one who is figuratively viewed to help learners become more aware of what is going on in the brain. It is not enough for a student to behave in a certain way - what's important is the thinking that goes on behind the behaviour. A large part of the role of a mediator (ie, teacher) is based on trust and rapport with the students being coached (taught). At the heart of cognitive coaching is the concept that each individual has resources that enable such an individual to grow and change from within, Costa and Garmston (1994) called these resources "states of mind". It is the state of mind that the teacher mediates, allowing the students to use their inner resources more effectively. Such states of mind are categorized into five as follows:

Efficacy:- knowing that one has the capacity to make a difference and being willing and able to do so.

Flexibility:- knowing that one has and can develop options to consider and being willing to acknowledge and demonstrate respect for empathy from diverse perspective.

Craftsmanship:- seeking precision, refinement and mastery, striving for exactness of critical thought processes.

Consciousness:- monitoring one's own values, intentions, thoughts and behaviours and their effects.

Interdependence:- contributing to a common good and using group resources to enhance personal effectiveness.

When students functions at their resourceful best, they are said to be holonomous. As coined by Arthur Koestler (1972), holonomy means to be simultaneously whole and part. A holonomous student is competent and confident as an individual in the organization, and at the same time critical to the effective functioning of the organization.

Cognitive Coaching has three maps as indicated below:

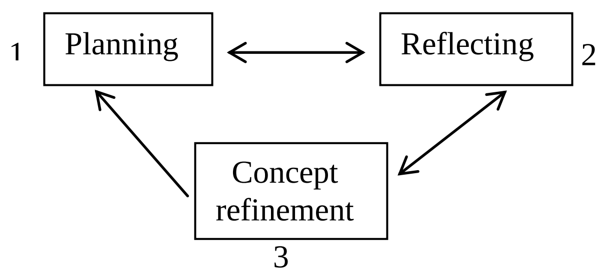

Fig 1.2: Adapted Cognitive Coaching Maps (Costa & Garmston, 1994)

The three maps interact with one another. When applied to Basic Science learning, it shows that as a student reflects on something he or she has done, he or she often begins thinking about the next activity or event and begins planning (the selection of appropriate strategies and the allocation of resources that affect performance), based on what he or she has learned from reflecting on a previous experience. Conceptual change can come from a student feeling "stuck" or can be part of reflecting or planning. When the student is "stuck" in his or her thinking, it is usually one or more of the states of mind that are causing the "stuckness". Costa and Garmston (1994) found that Cognitive Coaching supports instructional change, enhances peoples thinking, appreciates and celebrates diversity, promotes collegiality, develops coach (teacher) conceptual development as well as builds school culture. Cognitive Coaching enables the person being trained to evaluate what is good or poor, appropriate or inappropriate, effective or ineffective about his or her work. Cognitive Coaching is a powerful strategy for enhancing performance and building learning organizations.

The ability of the student to reach the level of right understanding of concepts through treatment intervention has a link with his or her mental ability. Mental ability is a clear case of theoretical constructs replacing functions which are indirectly measurable through performance (Bamidele, 2000). Ability is a general term used to refer to any characteristics of a person that makes it possible for him or her to carry out some sort of activity successfully. It covers broad traits such as intelligence as well as narrow traits such as manual dexterity. It refers to learned skills such as reading proficiency as well as to talents or aptitudes presumed to exist prior to learning. The terms mental ability and aptitudes are used synonymously in typical educational practice to denote an individual's potential for acquiring new knowledge or skill. Information about a student's potential may be useful in setting reasonable expectations for what he or she could accomplish, designing effective learning environments, and in diagnosing learning difficulties that the student may exhibit.

It is commonly accepted that individuals vary with respect to their specific mental abilities. A student may show superior linguistic or verbal ability while being relatively weak at spatial and mechanical reasoning tasks. The converse is also a common ability pattern. It is not known how many specific mental abilities there are or their degree of independence. Aptitudes are psychological constructs about individual differences in learning or performance in situations where individuals are required to learn from instruction. For a test to be an acceptable measure of verbal and spatial aptitude, it must be shown that individual differences in mental test performance are predictive of an individual's ability to learn in some specific instructional setting. Aptitude and achievement measures though, either may predict a student's ability to profit from a programme or course; the two types of tests are often quite different in content. The essential difference between achievement and aptitude tests is that the former attempts to measure abilities a student has acquired as a result of specific study in a given instructional sequence. In contrast, an aptitude test attempts to measure what a student has acquired as a result of more general experience. Theories of aptitude have been intimately tied to trends and developments in the area of mental testing. Historically, there have been two contrasting viewpoints which emphasize general mental ability versus specific abilities. A combination of both viewpoints is represented in hierarchical theories of aptitude and intelligence such as those advocated by

Cattel (1971) and Vernon (1979). The conception of aptitudes and abilities being developed by cognitive and developmental research is that it is possible to identify the components of individual differences in mental abilities in terms of dynamic process and knowledge structure concepts. Simple and complex performances demanded on aptitude tests, and that assists in the acquisition of academic knowledge and job skill, are being analysed in terms of the intellectual components involved in problem-solving, language, imagery, and knowledge representation (Vernon, 1979). These efforts help provide the missing theoretical basis for understanding, assessing, and developing mental abilities. This study employed the use of mental ability test to determine students' reasoning patterns in Basic Science.

Similarly, students' academic achievement cannot be alienated from their individual self-concept. This has been categorized as one of the sociometric variables. Among such other sociometric variables that have attracted researchers are self-based like life satisfaction among primary school pupils (Kaya and Siyes, 2008), self-esteem, academic self-concept and locus of control (Salami, 2005). The child's acceptance or rejection is a variable that attracted researchers. Salami (2005) in his finding established that a child's position with his or her peer group in a classroom is termed sociometric status and observes that both sociometric status and peer relation have both direct and indirect effects on achievement in English language. The term "self-concept" refers to a rather general human tendency – the tendency to regard oneself as an object. It is an abbreviated way of saying "attitudes towards and conceptions about one's self". Low self-concept has been identified by Salami (1987) and Busari (1991) to have contributed to poor academic achievement in science subjects. A favourable self-concept is essential to personal happiness and effective functioning, both in the student and in the adult (Aremu, 1997). Persons who seek psychological and psychiatric help frequently acknowledge that they suffer from feelings of inadequacy and unworthiness. They tend to perceive themselves as helpless and inferior, have difficulty, in either giving or receiving love, and tend to feel isolated and alone. They are likely to feel guilty, ashamed or depressed, and to derogate their own potential and accomplishments. Further stressed by Aremu (1997) it is not surprising that a high anxiety level and a negative conception of the self tend to be correlated. Furthermore, the anxious child's tendency to derogate himself or herself tends to generalize and affect his or her image of his or her bodily integrity and adequacy as well. A negative self-concept appears to promote defensiveness in the child's reactions to himself or herself and others. Finally, a negative self-concept appears to impair initial school adjustment and subsequent academic progress. A student's self-concept is affected by the way in which his or her peers and teachers respond to him or her; it appears likely that for most children the way in which they are treated by parents is of overriding importance in determining their perceptions of themselves (Aremu, 1997).

A number of other factors have been adduced as responsible for poor academic learning outcomes (ie, achievement and attitude) of students' in science subjects within Nigeria. Among such factors are negative attitude towards science (Jegede and Okebukola, 1986) as well as students belief system (Abimbola, 1977; Asonibare, 1984). Attitude is a predisposition to respond in a certain way to a person, object, situation, event or idea (Anderson, 1981). The response may come without conscious reflection. A person who shows certain attitude toward something is reacting to his or her conception of that thing rather than to its actual state. This shows, as Moffit (2001) concluded that, attitude is one of the important characteristics that determines pupils success and most importantly academic performance in school. An attitude is more enduring than a mood or whim; it produces a consistent response. Attitudes are closely related to opinions. A distinction can be made, however in that a person can state his or her opinion in words but may not be able to express his or her attitudes in the same way. He or she will reveal his or her attitudes by his or her actions and only directly by the content of his or her statements.

Attitudes are also related to prejudices. A prejudice is a rigidly fixed attitude, usually unfavourable, though a favourable prejudice is also possible. An attitude becomes a prejudice in Basic Science learning as in other spheres of life when the predisposition is so strong that no attention is paid to evidence that might call for a changed reaction. Scientific attitudes are formed as a result of some kind of scientific learning experience. In some cases the experience is one single dramatic or damaging event. Attitude may also be learned simply by following the example or opinion of a parent, teacher or friend. Attitudes are often built up more slowly such that growing up of a child in a happy home may contribute to a favourable attitude toward marriage. In addition to the home, important builders of attitudes are: schools, church and media such as newspapers and television. The agencies that help form attitudes can also change attitudes, though reshaping a deep prejudice may take years of effort – or even be impossible. The attitudes students hold can profoundly influence the way they act in personal and larger situations. For this reason psychologists and sociologists are concerned with how attitudes develop, how they affect behaviour, and how they can be changed. This study used conceptual change strategies to bring about favourable students' attitudes towards Basic Science.

1.2 Statement of the Problem

The relevance of Basic Science to technological development in Nigeria is very vital and the knowledge of the concepts in the subject is a pivotal to the scientific academic careers of students. This notwithstanding, only negligible sample of students made it to offer science courses at higher levels. This is confirmed in the recurrent mass failure (table 1.1) of students in the Junior Secondary Certificate Examination (JSCE) and has become a source of concern to stakeholders in Kwara State.

Although, parts of the efforts made to arrest the situation according to research findings include: the application of specific strategies as well as the state Government's Teacher Professional Development and supply of textbooks to schools, not much success has been recorded. It is germane therefore, to source for and address such other latent challenges which may include: students' cultural belief, conceptual ability, self-perceptual ability, personality disposition and individualistic knowledge acquisition that are seemingly remaining the cankerworms in the cog of the wheel of students' scientific conception. These challenges would need to be addressed by using strategies that can expose, resolve or overcome them. This can be done by finding out what students prior experiences are like and developing ways of monitoring their processes of conceptual understanding since the interference of these challenges can no doubt be part of the multiple factors militating against stakeholders efforts. It is on this premise that this study investigated the effects of two conceptual change strategies (Simplex and Cognitive Coaching) to improve Junior Secondary School students' learning outcomes as well as the retention capability of the learners over a given period. It also examined the influence of mental ability and self-concept on students' learning outcomes in Basic Science concepts.

1.3 Research Questions

The following research questions were addressed in the study:

1. What pattern of conceptual change would be exhibited on Basic Science concepts by the targeted students when they are exposed to Simplex and Cognitive Coaching strategies?
2. Which of the instructional strategies would influence students' retention of Basic Science concepts after four weeks of treatment?

1.4 Null Hypotheses

The study was conducted to test the following null hypotheses:

HO_1: There is no significant main effect of treatment (Simplex, Cognitive Coaching and Modified Conventional Method) on students'

(a) achievement in

(b) attitude towards and

(c) retention of Basic Science concepts.

HO_2: There is no significant main effect of mental ability on students'

(a) achievement in

(b) attitude towards and

(c) retention of Basic Science concepts.

HO_3: There is no significant main effect of self-concept on students'

(a) achievement in

(b) attitude towards and

(c) retention of Basic Science concepts.

HO_4: There is no significant interaction effect of treatment and mental ability on students'

(a) achievement in

(b) attitude towards and

(c) retention of Basic Science concepts.

HO_5: There is no significant interaction effect of treatment and self-concept on students'

(a) achievement in

(b) attitude towards and

(c) retention of Basic Science concepts.

HO_6: There is no significant interaction effect of mental ability and self-concept on students'

(a) achievement in

(b) attitude towards and

(c) retention of Basic Science concepts.

HO_7: There is no significant interaction effect of treatment, mental ability and self-concept on students'

(a) achievement in

(b) attitude towards and

(c) retention of Basic Science concepts.

1.5 Significance of the Study

The findings of this study are expected to provide empirical perspectives on conceptual change strategies on Basic Science learning in Nigerian Junior Secondary Schools as well as their reflection on students attitude towards the subject. The review made on literature in this study would serve as means of exposing Basic Science Teachers to a variety of exploits made by their counterparts in the area of science teaching all over the world through the application of conceptual change strategies to their classroom activities. It would as such give them the necessary impetus to aspire to do such seemingly impossible tasks through the use of the strategies in their classrooms. Findings of this study would as well provide a fore-knowledge to both the teacher and students on variables that may impede or enhance students learning outcomes in Basic Science so that they would be equipped to forestall the impediments while embracing and learning positive re-enforcers. The findings of this study would cause teachers to be excited to understand why student-related variables (attitude, mental ability, self-concept) might make or mar any significant contribution either singly or jointly to students academic progress. The essence of this lies in the fact that such variables that could have been neglected and assumed to be unimportant could have proved otherwise on students academic achievement.

The results from this study would provide a need for the teacher, parents, policy makers as well as the Government to create a mutually inclusive social environment equipped with necessary resources which could influence a motivating atmosphere for students to interact with one another as well as the teacher and the learning resources. This of course, would help to infuse and discard different cultural beliefs that could be incongruent with scientific ideas. The study would contribute to the overall consequence of constructivists principles of learning by doing since students would be made to do science rather than being told what would happen. This would in no small measure bring about improved learning outcomes in Basic Science examinations both at the internal and external levels. The findings would generate debates towards sensitizing serving Basic Science teachers on the need for professional development so that teachers are kept abreast of the innovations that could make their transactions efficient, effective and rewarding. The study would develop validated measurement scales that would be of immense value to knowledge. Also the validated empirical data which would be generated in this study would be useful to researchers in the nearest future in the area of science learning. Basic Science at the junior secondary is a subject that deals with integrating fundamental concepts in pure and applied sciences as well as social sciences. Hence, it exposes the students to what the future holds for them. A correct and possible perception of the biological, the chemical and the physical world on a sound foundation can only be gained by tailoring students' experiences towards the details of the universal occurrence. The researcher is of the opinion that the study of these concepts would bring about a conceptual change and retention in the learning of Basic Science.

1.6. Scope of the Study

This study covered co-educational junior secondary school two (JSS 2) students within Kwara State. Four Basic Science concepts were selected for the study as they formed the contents spirally arranged in the JSS Basic Science Curriculum. The concepts selected are: (i) habitat, (ii) rusting, (iii) energy, and (iv) simple machine; picked from the biological, chemical and physical aspects of science (Table 1.2). These were selected to:

(i) enable students to apply the knowledge gained to everyday life;
(ii) guide students on how to care for the resources around them and
(iii) develop scientific inquiry in the students'.

The levels of learning outcomes (achievement and attitude towards Basic Science) due to the selected Basic Science concepts were measured vis-à-vis the moderating effects of mental ability and self-concept. In addition, the level of conceptual retention after a time lag was also measured.

Table 1.2: Specification of Concepts for the Study

Unit	Main Concepts	Sub-concepts
1	Habitat	Meaning of habitat; kinds; biotic factor; abiotic factor; population density.
2	Rusting	Meaning of rusting; conditions for rusting; rusting and burning; prevention of rusting.
3	Energy	Meaning of energy; sources; forms; light rays, and reflection.
4	Simple machine	Lever, inclined plane and human body as complex machine.

The selection of the concepts rests on meeting the objectives stated below:

(i) to improve students' understanding of selected Basic Science concepts;

(ii) to enable students' apply the knowledge gained to their everyday life;

(iii) to guide the students' on how to take care of the resources around them;

(iv) to build scientific inquiry in the students'.

The topics were selected for examination in this study because the researcher beliefs that the poor performance of students in Basic Science at the junior secondary examination based on life, energy and environmental concepts as contained in the topics would continue and will adversely affect the day to day activities of the students if adequate and appropriate knowledge about the topics were not addressed; the topics also have direct link to socio-economic status of each student's family; further, they are of relevance to the well-being of the society of which the students are members considering the way people dwell together these days, manage their environment and the demand for energy for every day use.

1.7 Definition of Terms

The following terminologies were precisely defined:

Achievement: This refers to the scores obtained by Junior Secondary 2 students' on Basic Science concepts as measured by Basic Science achievement test.

Attitude: This embraces the reactions of J S 2 students' to specific opinions due to their exposure to certain conceptual change strategies as interventions on selected Basic Science concepts through Attitude towards Basic Science Scale.

Cognitive Coaching: is an instructional strategy that enables a teacher to mediate between Junior Secondary 2 students and their thinking on Basic Science concepts.

Conceptual change: Embraces the progress recorded by Junior Secondary 2 students from wrong to correct knowledge of Basic Science concepts.

Debriefing Protocol: This connotes the pre and post intervention interview in which 18 selected Junior Secondary 2 students responded to tasks on Basic Science concepts.

Learning outcomes: Are the Junior Secondary 2 students' obtained scores in achievement test and attitude towards Basic Science scale after being exposed to conceptual change strategies on Basic Science concepts.

Modified Conventional method: This is a strategy used for imparting Basic Science concepts to Junior Secondary 2 students' during which the teacher explains concepts and gives notes on the board.

Mental Ability: is the classification of Basic Science students' natural or acquired talent on both familiar and unfamiliar experiences with the use of mental ability test.

Misconceptions: are the wrong explanations made by Basic Science students about scientific concepts, which are in conflict with the generally accepted scientific meanings.

Prior knowledge: This refers to the local way of explaining scientific concepts by the Junior Secondary 2 students' before intervention in the Basic Science classes.

Retention: This is indicative of the Junior Secondary 2 students' ability to remember specific ideas about Basic Science concepts based on delayed post-treatment achievement test scores.

Self-Concept: Is the tendency of individual Junior Secondary 2 students' ability to regard self as an object among the peers in the course of learning Basic Science.

Simplex strategy: is an instructional strategy that involves the use of flash cards for recording ideas about a topic from which full knowledge about a concept can be obtained.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

The reviews of relevant studies in relation to this present study were presented in this chapter. It embraced a description of the theoretical and conceptual frameworks as well as the empirical bases that lend support to this study. The review is arranged in the following order:

2.1.1 Theoretical framework

2.1.2 Conceptual framework

2.2 Science Teaching in Nigerian Schools

2.3 Conceptual Change, retention and Teaching Strategies.

2.4 Assessment of Learning Outcomes in Basic Science.

2.5 Students' attitude towards science concepts.

2.6.1 Simplex and students' learning outcomes in science.

2.6.2 Cognitive coaching and students' learning outcomes in science.

2.7.1 Students' Mental ability and academic achievement in science.

2.7.2 Students' Self-Concept and conception of science concepts.

2.8 Appraisal of literature reviewed.

2.1 .1 Theoretical Framework

Constructivist Learning Theories

In the present millennium, there has been concerted effort to focus on individual learning which could help to address collaborative and social dimensions of learning. That is why this study rests on constructivist learning theory. Constructivism values developmentally-appropriate facilitator-supported learning that is initiated and directed by the learner. This way the theory posits that learners construct knowledge. Constructivism as a description of human cognition is often associated with pedagogic approaches that promote active learning which is learning by doing. Going by social constructivism point of view, it embraces the viewpoints of the works of Piaget, Bruner and Vygotsky.

Piaget Theory of Learning Schema

Piaget (1896-1980) considered constructivism an epistemology which argues that humans construct meaning from current knowledge structures. The theory of constructivism attributable to Piaget is such that articulate mechanisms by which knowledge is internalized by learners. This suggests that through the process of accommodation and assimilation, individuals construct new knowledge from their experiences. Researches in science education have concentrated on investigating theories and strategies that would facilitate understanding of scientific concepts and bring about conceptual change (Clement, 1993; Steinberg and Clement, 1997). Carey (1985) had suggested two types of knowledge restructuring, namely week restructuring and radical restructuring that are involved during conceptual change. Strike and Posner's (1985) work on the conceptual change view of learning and understanding is one of the popular theories used to explain how conceptual change happen in science education. In theory, accommodation is used to refer to large-scale conceptual changes and assimilation is used to earning in which a major conceptual change is oriented more to accommodation than to assimilation. They proposed that students conceptual ecology might influence their selection of new conceptions. Posner, Strike, Hewson and Gertzog (1982) suggested four conditions for accommodation (conceptual change) to occur: (a) students must be dissatisfied with their existing concepts, (b) students must have at least a minimal understanding of the new concepts, (c) the new concept must appear plausible and (d) the new concept should appear fruitful. Similarly, Strike and Posner (1985) had proposed that accommodation should be viewed as a competition between alternative conceptions. Once students are aware of an understandable and initially plausible alternative to an existing conception, the relative status of these conceptions becomes the issue. Dissatisfaction with the existing conception decrease its status, whereas exploring the fruitfulness of an alternative conception increases the alternative status (Hewson, 1983). Whenever the alternative's status exceeds the existing conception's status, accommodation will move forward. Piaget's theory stresses further that when individuals assimilate, new experience is incorporated into an already existing framework. This could be to, in one part, the alignment of the individuals' experiences with their internal representations of the world. It may on another part be due to failure to change a faulty understanding. However when there arise contradictions between individuals' experiences and their internal representations, the perceptions of the experiences may be altered to fit their internal representations. The theory maintains that accommodation is the process of reframing one's mental representation of the external world to fit new experiences. Thus, accommodation can be held as the mechanism via which failure leads to learning. By this, Piaget established that children progress through his four stages of mental development by applying their current thinking processes to new experiences and that they gradually modify these processes to better accommodate reality. This of course, occurs not through direct instruction, but rather through the child's own mental activity and internal motivation to understand.

Bruner Theory of Instruction

Bruner (1915-1995) believed that learning is an active process in which learners construct new ideas or concepts based upon their current or past knowledge. From this view the learner selects and transforms information, constructs hypotheses, and makes decisions, relying on a cognitive structure to do so. The possession of the cognitive structure (i.e., schema, mental models) provides the learner meaning and organization to experiences and allows him or her to "go beyond the information given". Provision of new mental set should therefore be the platform on which knowledge reconstruction can occur. Posner et al (1982) had suggested that students must see the new mental set as intelligible, plausible and fruitful for conceptual change to happen. It can be any type of instructional activity such as analogy, modeling, discrepant events and inquiry activities as long as it fulfils their suggestions and provides students with opportunities to visualize what actually happens, to reconstruct new mental sets. Structuring of such knowledge is achievable through modes of presentation such as: *Enactive* (learning through practice), *Iconic* (learning through visualization of image or picture) and *Symbolic* (acquiring knowledge through the use of language). To Bruner the four crucial aspects a theory of instruction is expected to address in the academic life of the learner include:

(i) predisposition towards learning,

(ii) the ways in which a body of knowledge can be structured so that it can be most readily grasped by the learner,

(iii) the most effective sequences in which to present material, and

(iv) the nature and pacing of rewards and punishments.

This means that good methods for structuring knowledge should result in simplifying, generating new propositions, and increasing the manipulation of information. This theory thus stipulates that the instructor should try and encourage students to discover principles by themselves while the instructor and student engage in an active dialog (i.e., Socratic learning). The task of the instructor here is to translate information to be learned into a format appropriate to the learner's current state of understanding. With all these in place, it is emphasized that the curriculum be organized in a spiral order to enable the students build upon whatever they have learnt continually.

Vygotsky Social Learning Theory

Vygotsky (1896-1934) viewed learning as an active process where learners' develop the ability to discover principles, concepts and facts for themselves; hence the importance of encouraging guesswork and intuitive thinking in learners. The theory highlights the convergence of the social and practical elements in learning by stressing that the most significant moment in the course of intellectual development occurs when speech and practical activity, two previously completely independent lines of development, converge. Through practical activity a student constructs meaning on an intrapersonal level, while speech connects this meaning with the interpersonal world shared by the student and his or her culture. The standard assert that active learning must involve interaction with others. This socio-cultural perspective of learning is supported by findings from a strand of research on social constructivism (Vygosky, 1978, Johnson and Driver, 1990; Scott, Asoko, Driver and Emberton, 1995). Socio-cultural cognitive models portray learning as a process of cultural apprenticeship in which knowledge is constructed as a result of social interaction. Learning science thus involves learning the ideas and practices of the scientific community and made meaningful at the individual level. Given this view, the teacher has two essential roles: (a) to provide opportunities for individual to engage socially in talk and activity about shared problems or task, and (b) to serve as expert who mediates social discourse and leads students to conventional science ideas (Driver, Asoko, Leach, Mortimer and Scott, 1994).

The constructivist learning theories and teaching methods of education are guided by the various arguments about the nature of human learning. Although constructivism does not by itself suggest any particular pedagogy, it describes how learning should happen, regardless of whether learners use their experience to understand a lecture or attempt to design a model airplane. Social constructivism views each learner as a unique individual with unique needs and backgrounds. The learner is also perceived as complex and multidimensional. The learner is encouraged to arrive at his or her own version of the truth, influenced by his or her background, culture or embedded worldview. Historical developments and symbol systems, such as the language, logic and mathematical systems are inherited by the learner as a member of a particular culture and these are learned throughout the learner's life. This also stresses the importance of the nature of the learner's social interaction with knowledgeable member of the society. It boils down to the fact that without the social interaction with other more knowledgeable people, it is impossible to acquire social meaning of important symbol systems and learn how to utilize them. Young students develop their thinking abilities by interacting with other students, adults and the physical world.

A constructivist learning intervention is one where contextualized activities (tasks) are used to provide learners' with an opportunity to discover and collaboratively construct meaning as the intervention unfolds. Learners are respected as unique individuals and instructors act as facilitators rather than as teachers. Most approaches that have grown from constructivism suggest that learning is accomplished best using a hands-on strategy. Learners learn by experimentation and not by being told what will happen. They are left to make their own inferences, discoveries and conclusions. It also emphasizes that learning is not an "all or nothing" process but that students learn the new information that is presented to them by building upon knowledge that they already possessed. Teachers will find that since the students build upon already existing knowledge, when they are called upon to retrieve the new information, they may make errors. It is known as reconstruction error when the gaps of their understanding are filled in with logical, though incorrect thoughts. Basic Science teachers need to catch and try to correct these errors, though it is inevitable that some reconstruction errors will continue to occur because of human innate retrieval limitations. Basic Science teachers also intervene when there are conflicts that arise; however, they simply facilitate the emphasis on the conflict being the students and that they must figure things out for themselves. Constructivism calls for the elimination of a standardized curriculum while advocating for the use of curricula customized to the students' prior knowledge and emphasizes hands-on problem solving. Under the theory of constructivism, educators focus on making connections between facts and fostering new understanding in students.

The implications of constructivists' theory in this study to the teaching and learning of Basic Science concepts include:

(i) It is important from social constructivist point of view to take into account the background and culture of the learner throughout the learning process, as the background also helps to shape the knowledge and truth that the learner creates, discovers and attains in the learning process.

(ii) Learners' and instructors have to develop an awareness of each other's viewpoints and then look to own beliefs, standards and values, thus being both subjective and objective at the same time.

(iii) Instructors have to adapt to the role of facilitators and not teachers.

(iv) It is important that instructors constantly assess the knowledge their students have gained to make sure that the students perceptions of the new knowledge are what the instructor had intended.

(v) Students have to present and train new contents with their classmates, so that a non-linear process of collective knowledge construction will be set up.

(vi) Instructors have to tailor their teaching strategies to student responses and encourage students to analyse, interpret and predict information

(vii) Teachers rely heavily on open-ended questions and promote extensive dialogue among students.

2.1.2 Conceptual framework

The conceptual framework of this study was developed to assess the effect of the concluding knowledge integration activity in terms of conceptual thinking. As an adapted framework and stemmed from a synthesis between the dimensions of systems thinking defined by Ossimitz (2000) and the element of systems thinking defined by O'Connor and McDermott (1997) (fig 2.1). This construct was used to build a continuum representing different degrees of conceptual understanding in this study. Ossimitz (2000) stressed that dimension of dynamic thinking is a critical aspect of concepts thinking. This dimension was placed on a continuum in which one side represents a static view and the opposite represents a highly dynamic view of the concepts considered in this study. A dimension of interconnectedness corresponding to the elements of conceptual understanding was superimposed on top of the continuum. It was claimed that, the more an understanding was based on critical reflections on the concepts in Basic Science, the more it expresses a higher dynamic view of the concept. The degree of critical reflections can thus provide a means for determining the degree of dynamics and vice versa.

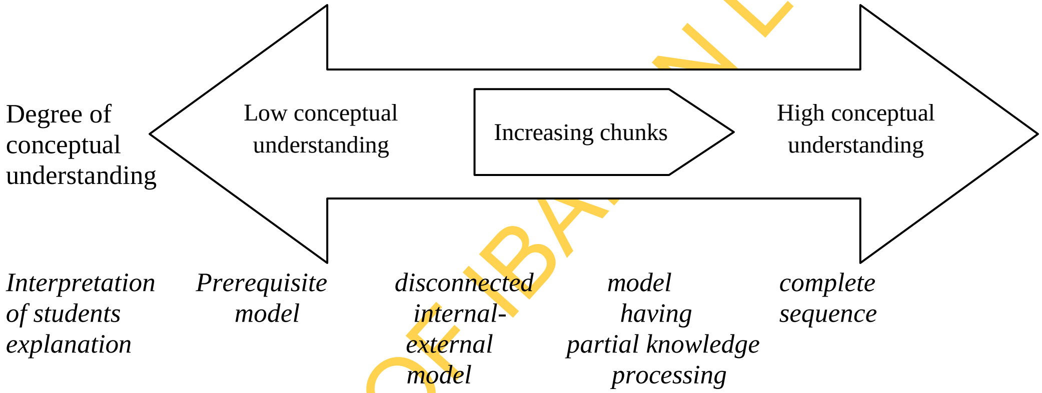

Fig 2.1: Adapted Conceptual Thinking Continuum by Kali, Orion and Eylon (2003).

Poor dynamic understanding that represents complete static view were indicated by incorrect answers with explanations classified as Prerequisite Model and placed at the left end of the continuum. Highly developed dynamic understanding that represents a complete dynamic view were indicated by explanations that reflect rich understanding and classified as Complete Sequence towards the right end of the continuum. With this view, students would be able to apply a holistic idea to scientific phenomena. This understanding was considered to be the highest level of conceptual understanding in Basic Science. Explanations indicating different degrees of conceptual understanding are placed between the two extremes. The

Disconnected Internal-External explanations reflect a larger chunks of conceptions. The Model Having Partial Knowledge Processing indicates explanations that reflect a view with fragments of sequence.

The progression within this continuum is considered to be the result of adding connections between pieces of knowledge, leading to higher levels of integrated knowledge. This view espouses the position of Smith, diSessa and Roschelle (1993) who stressed that the shift from "single units of knowledge to systems of knowledge with numerous elements and complex substructure" is a result of a "gradual change in bits and pieces" (p. 148). The adoption of this framework indicates that when conceptual change strategies are used, students in Basic Science can be made to transform from low conceptual thinking level (prior knowledge/misconception) through increasing chunks level (cognitive conflict) to high conceptual thinking level (scientific conception). This is possible because Simplex and Cognitive Coaching strategies expose students to the discovery of new experiences by themselves. They also help learners to appreciate the progress made in their learning process. Basic Science students' instructed by using Simplex and Cognitive Coaching strategies can gain more understanding by means of developing better ideas of the concepts.

These teaching strategies provided the means by which teachers and learners no longer view conceptual change as being influenced solely by cognitive factors, rather, affective, psychomotor, social and contextual factors also contribute to conceptual change. Simplex and Cognitive Coaching strategies considered those factors and strengthen interaction among students as well as between learners and the teacher. Considering these factors in teaching or designing learning environments do foster conceptual change (Duit, 1999).

2.2 Science Teaching in Nigerian Schools

Basic Science teachers in Nigeria have hitherto imparted scientific concepts to students by adopting different methods, transmitting information in a specific and peculiar language, made use of particular tools by complying with certain rules, etc. All these efforts were meant to help students understand scientific concepts legitimately. The history of science teaching in Nigeria dated back 1867 (Aworanti, 1991) during which Science was introduced as Nature Study and Hygiene. Aworanti (1991) stressed further that in a bid to step up effort towards presenting science to the students to reflect the culture and tradition of Nigerians, the idea of the Nigeria Integrated Science Project (NISP) was borne. This initiated the idea of teaching science as a unified whole. The objectives of the NISP as conceived by Science Teachers' Association of Nigeria (STAN) by 1970 were to enable students:

(i) observe carefully and thoroughly;

(ii) report completely and accurately;

(iii) organise information acquired;

(iv) generalise on the basis of acquired information;

(v) predict as a result of the generalizations;

(vi) design experiments (including controls, where necessary, to check the predictions); and

(vii) continue the process of inquiry when new data do not conform to predictions.

The recent education reform by NERDC (2007) necessitated another nomenclature for the subject as Basic Science but with a little restructured contents in the new curriculum. It was suggested that to achieve the objectives of learning the subject, the teaching of Basic Science should involve the use of discovery teaching tactics, problem-solving activities and open-ended field or laboratory exercises. Contrary to this suggestions, the studies of Jegede (1982) on evaluation of the Nigerian Integrated Science Project (NISP) after a decade of use in the classroom as well as that by Odubunmi and Balogun (1991) on the effect of laboratory and lecture teaching method on cognitive achievement in Integrated Science among others confirmed that teachers lectured and gave notes in Integrated Science (Basic Science) lessons. The non-compliance with the STAN's suggestions cannot but have serious implications for hands-on as well as minds-on activities on cognitive achievement in Basic Science.

Looking at Nigeria science teaching in comparison with other studies showed that laboratory based method where science process skills are emphasized could be effective in improving students' achievement in science (Erten, 2000; Serin, 2002; Cardak, Onder and Dikmenli, 2007). This finding is true if one should consider the contribution of processes of science to students' achievement. Science process skills provide students with unique opportunities to study abstract concepts and generalizations through the medium of 'real' materials. Thus, interaction of students with learning materials, teachers, classmates and practice what scientists do will make them develop skills needed for future work in science.

It seems however that larger number of the students could not harness the benefits inherent in those efforts as evident from assessment results. Finding had shown that students did not conceive studying science to be an easy task as they frequently believe that science classes are too difficult and too time consuming without seeing the potential benefits of science or where a particular science course fits into the "big picture" (New England Consortium for Undergraduate Science education (NECUSE), 2005). Literature have revealed that, a significant source of the learning difficulties experienced by science students in Nigeria lies in the knowledge they have acquired prior to instruction. Basic Science teaching and learning at the junior secondary level which forms a transition between the home knowledge or primary science experience and the senior secondary level pure sciences (Biology, Chemistry and Physics) has suffered a great set back. Research results have shown that:

i. Students from urban schools have more favourable attitude towards science than those from rural schools (Balogun and Odubunmi, 1983);
ii. Teacher's attitude towards science is a significant predictor of pupils science achievement as well as their attitude towards science (Onocha, 1985);
iii. Previous experience is considered to play a major role in determining an individual's performance (Onwu, 1981).

These problems are not limited to Nigeria alone; studies from other countries have shown that:

a. Students show limited demonstration of conceptual understanding and ability to analyse and apply scientific thinking processes (Mulli's and Jenkins, 1988; National Science Board, 2002),
b. Current earth science education is characterized by a shift toward a system approach to teaching and curriculum development (Mayer, 2002),
c. Earth science educators call for re-examination of the teaching and learning of traditional earth science in the context of many environmental and social issues facing the planet (Fortner and Mayer, 1998),

d. Systems thinking about the different earth systems, that is, the geosphere, hydrosphere, atmosphere and biosphere (including humanity) is fundamental to environmental literacy (Orion, 1998).

Aladejana (2007) observes in his study that science teaching (Basic Science inclusive) in Nigeria at the various levels of the educational system still retains the old conservative approach with the teacher in most cases, acting as the repertoire of knowledge while the students are the dominant recipient. There is over reliance on textbooks and only occasionally are demonstrations and experimental classes and if the situation would change, there is the need for a diagnostic study. The result of his study placed premium on the use of Information Communication Technology (ICT) in teaching as a relevant and functional way of providing education to learners that could assist in imbibing in them the required capacity for the world of work. Wolfram (2003) uses a New Kind on Science (NKS) approach to tackle a remarkable array of fundamental problems in science from the origins of apparent randomness in physical systems to the development of complexity in biology, the ultimate score and limitations in Mathematics and the possibility of a truly fundamental theory of physics (Boguta, 2004).

Teaching approaches should change from teacher-based instruction to learner-based learning where teachers facilitate learning and this can be largely achieved with Simplex and Cognitive Coaching strategies. With the increased momentum for scientific and technological revolution radiating across the world, Simplex and Cognitive Coaching strategies would help to change the teaching and learning of science in Nigeria schools such that the students would play active role. Anyanechi (2008) in her study on teaching science in Nigeria secondary schools using a constructivist model found that the strategy resulted in new experiences and new ways of thinking and experiencing among members of a group. She further opines that the use of a constructivist model created a better and broader experiencing of the environment and understanding. By suggesting different approaches to science teaching, she observes that familiar instructional materials may contribute to enhancing students' cognitive styles.

For the Nigerian-would-be future scientists (young students) to be able to interact intelligently anywhere globally, they need to be equipped adequately with scientific potentials if we determine to compete well with the present scientific and technological civilization. Many findings have indicated that science teaching or the quality of science instruction in Nigeria had suffered a great set back as Omotayo and Olaleye (2008) summarized the allegations against quality science instruction to include:

(i) over-emphasis on mastery of content matter against acquisition of practical science process skills,

(ii) total lack or insufficient participation of students in the learning process,

(iii) preponderance of teacher authoritarianism and theory based didactic science classes and

(iv) inability of students to perform important science process skills practically.

This showed that in Nigeria science is handled as any other subjects culminating into making science an abstract to the students rather than as a tool for industry.

Shechtman and Leichtentritt (2004) in their study in Israel found and posited strongly that the third level teaching model (which concerns the affective domain) is a teaching device used to increase students' personal and emotional involvement in the learning process. They also found out that during affective periods in the learning process, there are fewer disciplinary problems and students are usually more self explorative and supportive to each other. The quality of science education needed in Nigeria to keep abreast of the present global scientific civilization should be the type that is connected to the real world of the learner. The model of teaching that would make them self-explorative, gain insight into the problem situation, acquire problem solving skills and have a form of self-understanding of the environment.

The exemplar scheme is underpinned by assumptions about the aims and purposes of teaching science. Science teaching is expected to offer opportunities for students to:

(i) develop knowledge and understanding of important scientific ideas, processes and skills and relate these to everyday experiences,

(ii) learn about ways of thinking, and of finding out about and communicating ideas, and

(iii) explore values and attitudes through science.

These will increase students' curiosity about things they observe, and experience and explore the world about them with all their senses. These experiences could also be used to develop their understanding of key scientific ideas and make links between different phenomena and experiences. In addition, students could be prompted to acquire and refine the practical skills needed to investigate questions safely as well as develop skills of predicting, asking questions, making inferences, concluding and evaluating based on evidence and understanding and use these skills in investigative work. By observing students developing understanding of scientific knowledge and ideas, teachers will be able to ascertain what tasks and expectations would best support their learning.

The Art of teaching science emphasizes a humanistic, experiential and constructivist approach to teaching and learning, and integrates a wide variety of pedagogical tools. It is imperative therefore to encourage students to construct ideas about science teaching through their interactions with peers, mentors, and instructors, and through hands-on or minds-on activities designed to foster a collaborative, thoughtful learning environment. The above among others, revealed established and convincing evidences that called for critical re-examination of the processes involved in the teaching of Basic Science in Nigeria. This study used two conceptual change strategies on students learning outcomes in Basic Science.

2.3 Conceptual Change, Retention and Teaching Strategies

Teaching for conceptual change is necessary to enable students modify their naïve idea of science to reflect the scientific ones. As growing members among science educators and with the recent curriculum innovation in Nigeria, the Basic Science teachers are expected to always teach the subject for "conceptual change". Similarly, educators need to understand how prior knowledge affects learning if they want students' to make the most of a new experience. Conceptual change is generally viewed as learning that changes an existing conception (i.e, belief, idea, or way of thinking). The shift or restructuring of existing knowledge and beliefs is what distinguishes conceptual change from other types of learning. Learning for conceptual change is not merely accumulating new facts or learning a new skill. In conceptual change, an existing conception is fundamentally altered or even replaced, and become the conceptual framework that students use to solve problems, explain phenomena, and function in their world. Articulating and committing to memory of the conceptual framework is necessary for the learner to continue to function in the said world. Teaching for conceptual change as reported by Davis (2001) primarily involves:

(i) uncovering students' preconceptions about a particular topic or phenomenon and

(ii) using various techniques to help students change their conceptual framework.

Similarly, teaching for conceptual retention involves engaging the students' in some tasks requiring deep reasoning, manipulation and expression of their opinion –"I know because I do". The fast majority of researches on conceptual change instruction have been confined to science, however, outside of school, students develop strong misconceptions about a wide range of concepts related to non-scientific domains, such as how the government works, principle of economics, the utility of mathematics, the reasons for the Civil Rights movement, the nature of the writing process, and the purpose of the electoral college. Conceptual change instruction can help students overcome misconceptions and learn difficult concepts in all subject areas as well as help students to retain the acquired knowledge.

This is in line with the view that Social constructivists and cognitive apprenticeship perspectives have each or both influenced conceptual change (Hewson, Beeth and Thorley, 1998). Thus, the students taught with the adoption of Simplex and Cognitive Coaching strategies could be encouraged to display overly a higher and better learning outcomes than those engaged in the Modified Conventional strategy. It is so because the strategies hinge on the constructivists approach to learning which stresses the vital role of the learner in learning process, that knowledge acquisition is not the mere accumulation of new facts, but a process that entails restructuring of knowledge as learners make sense of new information (Smith, Carey and Wiser, 1985) while Von Glasersfeld, (1981, 1994) opine that constructivist tradition focuses on individual activity and the importance of exploring physical phenomena as a starting point for personal construction of meaning. These views on learning encourage discussion among learners and the instructor as a means of prompting conceptual change.

In science education, concept mapping has been widely recommended recently and used in a variety of ways among other strategies. It has been used to help teachers and students to build on organized knowledge based in a given discipline (Pankratius, 1990), it has been used to facilitate middle level students learning of science content (Duru and Gurdal, 2002). Findings from literature indicate that concept mapping is an effective tool for aiding students' comprehension and retention of science materials. Research shows that students better remember information when it is represented and learned both visually and verbally. Different methods have been used as visual learning tools that help students' think, learn and achieve. Asan (2007) reports that concept mapping contributed to students' success, foster a long-term change in thinking as well as changed students' learning strategies. However, concept mapping is disadvantageous to students who could not understand concept meanings, organize concepts hierarchically and form meaningful relationships between concepts to form a coherent, integrated network of the material learned in addition to been individualistic and a great deal of time wasted in guiding students through the process.

Follow-up tests at various intervals following instruction reveal that students retained information they learned via graphic organizers. In a study, graphic organizers were also found to help students transfer retention and recall skills to new situations (Griffin, Malone and Kameenui, 1995). Inquiry based teaching has been reported by Neo, Khiang, AbdulRahim, Hui, Hoong and Naidu (2000) as useful tool to take on many forms with most descriptions emphasizing investigations and that “science process skills” are best learned by inquiry approach. This method however suffered to deliver due to care-free attitude of teachers to practice an activity before teaching it let alone encouraging students to investigate things by themselves. In the field of sport, Boyce (1992) investigated the effect of command, practice and inclusion styles with University students’ on a rifle shooting skill and found that command and practice styles are superior to the inclusion style for the acquisition and retention of the skill. The above referred researches increasingly support the idea that the use of conceptual change strategies which in this study, Simplex and Cognitive Coaching tools are employed can extend and enrich students’ learning in Basic Science in important and unique ways.

2.4 Assessment of Learning Outcomes in Basic Science

Assessment is the systematic collection, review and the use of information about educational programs undertaken for the purpose of improving students learning and development (Palomba and Banta, 1999). Assessment in higher education for instance provides tools and information that enable teachers to discern whether they are achieving their personal goals and the goals of their institution (Skocpol, 2009). These goals embrace the three types of assessment identified by Earl (2004) as: summative assessment or assessment of students learning; formative assessment, or assessment for learning; and assessment of learning. Summative assessment is the judgment of "the degree and quality of students learning so that it can be reported". This straight forward goal is the focus of much discourse on assessment. Formative assessment predominantly occurs in the classroom through observation or exercises intended to provide instructors as well as students with information about students progress. Assessment as learning focuses on the student, involving him or her as an assessor and fostering self-assessment (Voparil, 2009). In both formative assessment and assessment of learning, the process itself becomes a teaching tool. Deardroff, Hamann and Ishiyana (2009) had submitted that in political science, an important new edited volume had opened a window on the expansion and enhancement of assessment, including how to transfer a culture of assessment, create assessment plans and design or implement standard scoring instruments, portfolios and other techniques in both conventional and virtual classrooms. As such, political science departments as reported by Young (2009) are using an increasingly broad set of direct or indirect and external or internal measures of student learning for purposes of programme evaluation. His report further revealed that the external measures employed include rationally recognized examinations as direct and surveys of students engagement as indirect while internal measures include such strategies as the use of portfolios, team scoring of students work and simulations as another direct means or students interviews and surveys also as indirect means. Learning outcomes are the specific intentions of a programme or module written in specific terms. They describe what a student should know, understand or be able to do at the end of that programme or module. Learning outcomes are concerned with the achievements of the learner rather than the intentions of the teacher. They can take many forms and can be broad or narrow in nature (Adam, 2004). Learning outcomes and "aim and objectives" are often used synonymously, although they are not the same. Adam (2004) notes that "Aims are concerned with teaching and the teacher's intentions whilst learning outcomes are concerned with learning". Moon (2002) at another end suggests that one way to distinguish aims from learning outcomes is that aims indicate the general content, direction and intentions behind the module from the designer or teacher viewpoint. However, learning outcomes and objectives are more difficult to distinguish as objectives can be written in terms that are very similar to that used in learning outcomes. Nevertheless, learning outcomes in science have been viewed as the expression of what a student will demonstrate on the successful completion of a module (University of Exeter, 2004). Thus, learning outcomes in Basic Science are related to the level of the learning, indicate the intended gain in knowledge and skills that a typical student will achieve, and should be capable of being assessed.

Students' learning outcomes in science are properly defined in terms of the knowledge, skills and abilities that a student has attained at the end of his or her education experiences. Students have to have a certain library of information, a certain number of facts since one cannot operate without a collection of knowledge. The students should as well have developed some specialized skills and some critical appraisal ability. It should not be surprising that the specific knowledge most valued varied between individuals. However, there are several themes which emerged repeatedly. A variety of specific skills and knowledge to be important for students' in Basic Science include:

(i) scientific methodology, including the central role of hypothesis development and testing,

(ii) Quantitative skills, because science is about measurement,

(iii) Data analysis, including relevant intelligent skills and statistics,

(iv) Observation skills, including the ability to record observation accurately,

(v) Understanding scientific conventions and

(vi) Familiarity with key techniques and methods as appropriate to the areas within Basic Science, including activity skills.

The mental ability, cognitive achievement and the level of retention of Basic Science concepts were assessed in this study as means for ascertaining the extent to which students could learn scientific concepts in Basic Science.

2.5 Students' Attitude Towards Science Concepts

The human specie is endowed with the instinct of perceiving events differently. This allows every individual to react to phenomena relative to their perception. Thus, people could see science as indispensable to life or as a big-bang on which the end of life rests. It has been observed that scientific endeavours had enabled successive generations to achieve an increasingly comprehensive and reliable understanding of the human specie and its environment, (Pena and Paco, 2004). In line with the assertion, Medicine has had to be guided by science. Nonetheless, the fact that uncertainty is inherent in medical practice, as well as, the existence of some procedural norms that are not based on the scientific method have reinforced the view of those who claimed that medical practice is to be understood as both an art and a science (Saunders, 2000). This mentality is characterized by a permanent willingness to apply scientific habits of mind in a wide range of social contexts. Also it subsumes attitudes, views, cognitive abilities and behaviuors coherent with science. An examination of the major goals to science education reveals unanimity of opinion that the development of scientific literacy includes the development of positive attitudes toward science.

Pena and Paco (2004) maintain in their study that students show favourable attitudes toward science as most student respondents in their study claimed to rely on science as the best source of knowledge. Nevertheless, a sizeable portion of students have some reservations concerning science and technology as revealed from their study on attitudes and view of medical students towards science and pseudoscience, more than half of the respondents thought that science has made our lives more stressful, and most believed that most scientists serve political power. Other studies have related specific strategies to favourable attitudes among the learners. Such studies have analysed the efficacy of teaching and indicated the necessity of active learners work on mathematics lesson. Emphasis is laid on the fact that used activities do attract learners attention as well as motivate them. These activities also positively influence learners emotion, attitudes and benefits linked with mathematics and its teaching and develop various needed skills and competencies (Brooker, 2000). In like manner, Vankus (2005) studied the psychological effects of didactical games on mathematics lesson and found that they have positive influence on learners mathematics knowledge and also changes in many other factors in the environment of classroom. The result of this study thus revealed that the most important is the increase of learners inner motivation and some improvement of learners mathematical knowledge as well as positive changes in learners attitudes towards the subject. The findings of Carnagey and Anderson (2005) on the influence of videogames on youth revealed that when a car racing game rewarded players for violent acts, those players were more likely to attack an opponent than when the same game punished players for aggression. Further, Dill, Brown and Collins (2007) found from their study on stereotypical portrayals of women minorities in video games and the adverse effects of those characterizations, that a positive association existed between violent video game play and anti-women attitudes including attitude supporting violence against women. They equally found that youth exposed to sexist images of video games characters were more likely to accept rape myths than youth exposed to images of professional men and women. In the past, researchers have highlighted and specialized on the reason for the decline in attitudes toward science between elementary and middle school grades. Findings of Talton and Sumpson (1986) revealed that students who held positive attitudes toward science in the elementary grades often indicated that their families had fostered their interest in science.

From the aforestated, it is predicated that a number of factors could influence learners attitude towards a discipline. It is therefore necessary to identify factors that may count very important in shaping students attitudes towards Basic Science as well as embarking on qualitative measurement of the effect of an intervention programme which the present study examined critically. The examined areas for change and study involved the type of strategies employed by teachers, perceived relevance of materials and content and the extent of exposure that students have on Basic Science concepts. By these, it was believed that the students would prefer to be actively involved in learning activities.

2.6.1 Simplex on Students' Learning outcomes in Science

Simplex process has been extensively documented in the management and creativity literature. The practical synopsis of the steps involved is circular in nature. Hossein (1999) in his analysis of the classical simplex method found that Simplex is a group process for finding and solving problems; identifying and overcoming challenges; and establishing and achieving goals. This implies that the use of Simplex allows individuals and organizations to be creative, innovative and to succeed in a world where fast-paced change is the order of the day. During the American effort in World War II (1941-1945), there was a great need to improve systems of supply, manufacturing, and shipping under time, budget, and manpower constraints. This need to streamline large systems created a need in some ways to simplify and automate the evaluation of a huge number of choices. An effort was made to use electronic computers, which were just becoming available to large instructions, for the calculations. In 1947, the new field of linear programming began with the discovery by Mathematician George Danzig of a way to simplify many of the calculations. His discovery is known as the Simplex method.

The Simplex method has been found to reduce the calculations necessary to maximize the objective function. For situations that involve only two products, Simplex method says that when a set of points (x, y) is bounded by straight lines, forming a polygon, the maximum and minimum values of a linear function p (x, y) occur at the vertices of the polygon, (John, William and Stephen, 1998). If the greatest value of the objective function occurs at a point whose coordinates are not integers, then the Simplex method directs human attention at acceptable nearby points. Due to Simplex method, it is only necessary to compute the value of the objective function at each vertex, not at the interior points. In the same vein, Richard (2005) used simplex algorithm to solve linear programming problem by maintaining that simplex algorithm is normally an efficient way to solve a general linear programming problem. It is well known that Simplex method is used in variety of ways in Mathematics to solve linear programming problems; it can as well be used in other subjects especially in learning Basic Science as an innovation in Nigeria to boost students' achievement.

2.6.2 Cognitive Coaching and Students' Learning Outcomes in Science

Cognitive Coaching requires systemic and long-term investment to create a culture that values the development of thoughtful teaching and administrative practices, self directed learning and a support for mediation of thinking. This is not an idle venture. Finding from the investigation carried out by Edwards (1993, 2005) on the effect of cognitive coaching on conceptual development and reflective thinking of first year teachers had established a direct link between the types and qualities of teacher thinking and students' outcomes. Traditional models on supervision and coaching have focused on installing and extinguishing certain teacher behaviuors. These approaches have had limited success and over time, have narrowed teachers' conceptual frameworks. Cognitive Coaching focuses on the internal thinking and decision making capabilities of the teacher. A focus on these skills helps teachers to generate new possibilities, increase instructional flexibilities, and focus on outcomes, not problems, (Costa and Garmston, 1994).

The main tools of Cognitive Coaching are: rapport, meditative questioning, response behaviours, pacing and leading (Edwards and Green, 1999). It is crucial that the students learn these tools and use them as the major focus of Cognitive Coaching is trust and rapport. For a purposeful application of Cognitive Coaching, it distinctively demands that the people involved in its application undertake the following:

(i) build trust by developing physical and verbal rapport,

(ii) facilitate thinking, questioning and developing greater precision in language,

(iii) develop a student's autonomy and sense of community by increasing his or her sense of efficacy and self-awareness,

(iv) apply coaching skills which enhance the intellectual process of performance.

Precision in language leads to precision in thinking as Joyce and Showers (1995) had established from their study on student achievement through staff development that there is a direct link between the languages that teachers use and their thinking quality. Cognitive Coaching leads to greater language precision for all involved. This linkage extends to the quality of students' thinking in the classrooms of those same teachers. Further, Cognitive Coaching includes skills development in questioning and response behaviours appropriate to adult interaction and teacher and students interaction as well. Teacher's question and response behaviours and language pattern cue students' thinking, mediate students' responses, focus students' attention on details and essential processes and convey caring and expectations (Costa and Garmston, 1994). Cognitive Coaching has been used extensively to seek out students language pattern, it is equally believed that it can be adapted as an innovation to enhance language precision in learning Basic Science in Nigerian schools.

2.7.1 Students' Mental Ability and academic achievement in Science

Abilities are determined in complex ways. Heredity always plays a part, but practice and training usually seem to be involved as well. The structure and condition of various parts of the body help to determine the level of functioning of some abilities, but mental qualities are even more important. For example, an individual's brain is more influential than his eye muscles in determining his or her level of reading ability. This is the more reason why Douglas (2007) in his analysis of intelligence opined that up to some usually unattained physiological limit, any ability can be increased through training- a kind of goal striving. Goal striving refers to the ways in which people manage their thoughts and actions while working towards an outcome (Gollintzer and Brandstatter, 1997; Diefendorff, Hall, Lord and Strean, 2000). In other words, a self-regulation effort continually required in the learning environment as learners attempt to accomplish various goals and assignments. In the field study of sales people for instance, Vandewalle, Brown, Cron andSlocum (1999) found that a learning goal orientation (but not a performance goal orientation) predicted an emphasis on skill building which in turn predicted greater sales performance.

The antecedent of the influence of the conceptual change strategies used and mental ability on learning outcomes was examined in this study to reflect the recommendation of self-regulation scholars that process model be hierarchically organized to reflect how distal disposition traits influence outcomes through progressively more proximal process (Chen, Whiteman, Gully and Kilcullen, 2000; Vallerand, 2000). For instance, Vallerand (2000) argued that three levels of abstraction and the relationship among variables within them predict outcomes like a situational level that reflects responses to a specific situation. Similarly, Elliot and Church (1997) had earlier argued that achievement goals that mediate the effects of global motivational theory of autonomy in motivational processes comes to the fore, proposing that individuals are motivated when their self-determined behaviour feels freely chosen and reflects personal values (Ryan and Deci, 2000). Evidence of relationship between mastery pattern and goal level has been recorded from the study of Chen et al (2000) that mastery pattern involves challenging oneself for the sake of skill development and self improvement and achieving personal standards of success. These personal standards may or may not coincide with normative standards used to judge performance outcomes such as grades or rating levels on a performance evaluation form. It was assumed that mental ability would predict learning outcomes among Basic Science students in this study.

Douglas (2007) observed that Thurstone has proposed that intelligence was not one general factor, but a set of independent factors of equal importance. He called these factors *primary mental abilities*. Seven such primary mental abilities were thus identified to include:

(1) verbal comprehension, the ability to understand word meanings;

(2) verbal fluency, or speed with verbal material, as in making rhymes;

(3) number, or arithmetic ability;

(4) memory, the ability to remember words, letters, numbers, and images;

(5) perceptual speed, the ability to quickly distinguish visual details and perceive similarities and differences between pictured objects;

(6) inductive reasoning, or deriving general ideas and rules from specific information; and

(7) spatial visualization, the ability to mentally visualize and manipulate objects in three dimensions.

Mental abilities represent a person's "brain power" in different areas of competency. Some typical mental abilities include: verbal reasoning, mathematical reasoning, spatial reasoning and logical reasoning. Sometimes, psychomotor skills such as reaction time are also considered to be mental abilities. Many researchers now believe that there is a general underlying factor that explains most mental abilities (sometimes called “g”, for “general factor”), and that people with higher levels of this general ability tend to be more successful in life, including at work. Other researchers believe that this general mental ability is important, but that other abilities (eg, musical, practical, emotional) also play a key role in a person’s success.

Companies, government agencies, and the military have used mental ability testing for decades to assess job applicants prior to employment. The assumption underlying this practice is that people with a higher level of mental ability will perform better on the job. Mental ability tests do not tell the whole story, though, they tend to predict core task performance well, they are less effective at predicting interpersonal performance or dependability. Similarly, mental ability tests tend to demonstrate adverse impact against legally protected groups. However, the scientific evidence compiled from hundreds of studies is clear- mental ability test scores predict:

(i). new employee performance during job training, and

(ii). supervisor ratings of employee performance on the job.

People with higher ability scores tend to be better job performers. This relationship holds for most jobs types in the economy and especially true for jobs with higher reasoning demands, such as managerial and professional positions. Mental ability test was administered on the students in this study and the scores obtained provided the means by which the students were categorized into: high, medium and low. This was necessary because the pattern of conceptual change on the part of the students about the Basic Science concepts selected was based on these levels of mental reasoning.

2.7.2 Students' Self-Concept and Conception of Science Concepts

Social workers are constantly seeking useful data regarding methods of behaviour change. Changes in self-concept can mediate changes in overt behaviuor. Self-concept has been reawakened as a focus of empirical research. Several literatures (self-perception theory, cognitive dissonance theory, and the availability heuristic literature) suggest ways of changing the Self-Concept. Jim's (2008) findings on shaping self-concept-encouraging kids to take risk and earn revealed that the key to helping students' develop high self-concept is to nurture and encourage him or her in areas of natural talent, interest, and strength rather than to focus on his or her weaknesses.

Researchers have identified three perspectives about the relationship between academic achievement and self-concept of students. First, academic achievement has been proposed to exert a positive effect on students self-concept via skill development model (Pottebaum, Keith and Ehly, 1986). Second, another school of thought maintained that students self-concept was expected to be a prerequisite to enhancing their academic performance as held by self-enhancement model (Wigfield and Karpathian, 1991). The third perspective as established by the reciprocal model stresses the existence of mutual causality between students' academic self-concept and academic achievement (Hansford and Hattie, 1982; Pajares and Schunk, 2001; Guay, Marsh and Boivin, 2003). It was inferred that students with positive academic self-concept tend to invest more time to engage in learning activities in corresponding learning subject. This by extrapolation indicated that the time spent to study other learning subjects by such students will relatively decrease. In like direction, Harter (1986) found from his work on process underlying children's self-concept established that general or global self-concept can be determined by the degree of importance that we assign to each of its specific components. This means therefore that when we describe ourselves and our value judgments are satisfactory, then we shall obtain a positive global self-concept while the reverse generates negative feelings that produce negative global self-concept.

Francisco, Paretta, Maria and Sanchez (2003) maintained that self-concept is a set of perceptions or reference points that the subject has about himself or herself. It is the set of characteristics, attributes, qualities and deficiencies, capacities and limits, values and relationships that the subject knows to be descriptive of himself or herself and when he or she perceives as data concerning his or her identity. This implies that self-concept is the set of knowledge and attitudes that an individual has about self; it is the perceptions that an individual assigns to self; the characteristics or attributes that people use to describe themselves. Self-concept is understood to be fundamentally a descriptive assessment and has a cognitive nuance. The importance of self-concept and academic achievement in primary school pupils as the perception that each one has about oneself, formed from experiences and relationships with the environment where significant people play an important role. Corroborating other researchers viewpoint, Francisco, et al (2003) opined that self-concept could be viewed as a compendium of seven characteristics or fundamental aspects consisting:

(i) a psychological dimension;
(ii) it is multidimensional;
(iii) it has a hierarchical organization;
(iv) it is stable, but as we go lower on the hierarchy, self-concept becomes more specific and more susceptible to change;

(v) the different facets of self-concept become more differentiated among themselves with age and experience;

(vi) self-concept includes both descriptive as well as evaluative aspects;

(vii) self-concept can be differentiated from other constructs which it is related to, such as academic performance.

In spite of the abundant studies on self-concept and performance, there are no conclusive studies that clearly identify the direction of the link which joins these two variables. It is germane as a result to identify the possibility of the influence of the conceptual change strategies and self-concept on academic performance as pursued in this present study.

2.8 Appraisal of Literature Reviewed

Studies on different approaches to science teaching from literature showed that science educators in Nigeria have adopted series of methods (inquiry, discovery, concept mapping, individualized, peer grouping, etc), these strategies however did not lay much credence to conceptual change so much so that the use of Simplex and Cognitive Coaching as teaching or conceptual change strategies was not found in literature as it applies to science teaching in Nigeria. Teaching for conceptual change as revealed from literature has been done without consideration for retention in the pure and applied sciences, thus the efficacy of the conceptual change strategy investigated in this study on retention in Basic Science has not been undertaken. The efficacy of different approaches on learning outcomes were reviewed but none has ventured into using those used in this study in Basic Science. Most of the literature reviewed emphasized the impact of attitude (teachers and students) on achievement, others stressed the effect of strategy on attitude but literature was devoid of relating the strategies used in this study to students' attitude in any discipline in Nigeria.

The literature reviewed also indicated that Simplex method has been extensively applied in mathematics, engineering and medicine, while Cognitive Coaching has been applied in teacher efficacy in the languages; this study pioneers the usage of the strategies in the teaching of Basic Science concepts. Literature showed that studies were found of investigating the causality or relationship of the main influence of specific independent variables on specific dependent variables with respect to related moderator variables, the present study is unique in that no study from the literature reviewed was discovered to have related the impact of Simplex and Cognitive Coaching strategies with respect to the moderating influence of mental ability and self-concept on learning outcomes in the sciences, technology, social sciences, languages, religions or philosophy, etc. In view of the discoveries above, the present study determined the effectiveness of Simplex and Cognitive Coaching as conceptual change strategies on students learning outcomes in Basic Science with consideration of the students mental ability and self-concept alongside.

CHAPTER THREE

RESEARCH METHODOLOGY

This chapter examined the following:

(a). Research design

(b). Variables

(c). Population and sample

(d). Research instrument

(e). Procedure for data collection

(f). Procedure for data analysis.

3.1 Research design

This study adopted a pretest-posttest, control group, quasi-experimental design. In addition, a delayed post-test was carried out in order to obtain data on students retention. The schematic representation of the research design is shown below:

O_1	X_1	O_2	(E_1)
O_3	X_2	O_4	(E_2)
O_5	X_3	O_6	(C)

Where:

O_1, O_3 and O_5 represent pretest scores for Experimental groups 1, 2 and control group respectively.

O_2, O_4 and O_6 represent post-test scores for Experimental groups 1, 2 and control group respectively.

E_1 represents experimental group 1.

E_2 represents experimental group 2.

C represents the control group.

X_1 represents treatment mode of Simplex instructional strategy.

X_2 represents treatment mode of Cognitive Coaching instructional strategy.

X_3 represents the control mode of Modified Conventional method.

This design employed the use of a 3 x 3 x 2 factorial matrix. The 3 x 3 x 2 factorial matrix adopted has the instructional strategy at three levels (SS, CCS and MCM) crossed with mental ability at three levels (high, medium and low) and self-concept at two levels (high and low).

Table 3.1: The 3 X 3 X 2 factorial matrix

Treatment	Self-Concept	Mental Ability		
		High	**Medium**	**Low**
Simplex Strategy	High	X	X	X
	Low	X	X	X
Cognitive Coaching Strategy	High	X	X	X
	Low	X	X	X
Modified Conventional Method	High	X	X	X
	Low	X	X	X

3.2. Variables of the Study

The variables that had necessary consequence in this study are as indicated below:

Independent Variables

The independent variables were the mode of instructional strategy which varied at three levels:

(i). Simplex Strategy (SS).

(ii). Cognitive Coaching Strategy (CCS).

(iii). Modified Conventional Method (MCM).

Moderator Variables

The two moderator variables that were considered are:

(i). Mental Ability at three levels (high, medium and low)

(ii). Self-Concept at two levels (high and low).

Dependent Variables

The dependent variables assessed on the concepts in Basic Science in this study are the learning outcomes which were at three levels:

(i). Achievement in Basic Science concepts.

(ii). Attitude towards Basic Science concepts.

(iii). Retention of Basic Science concepts.

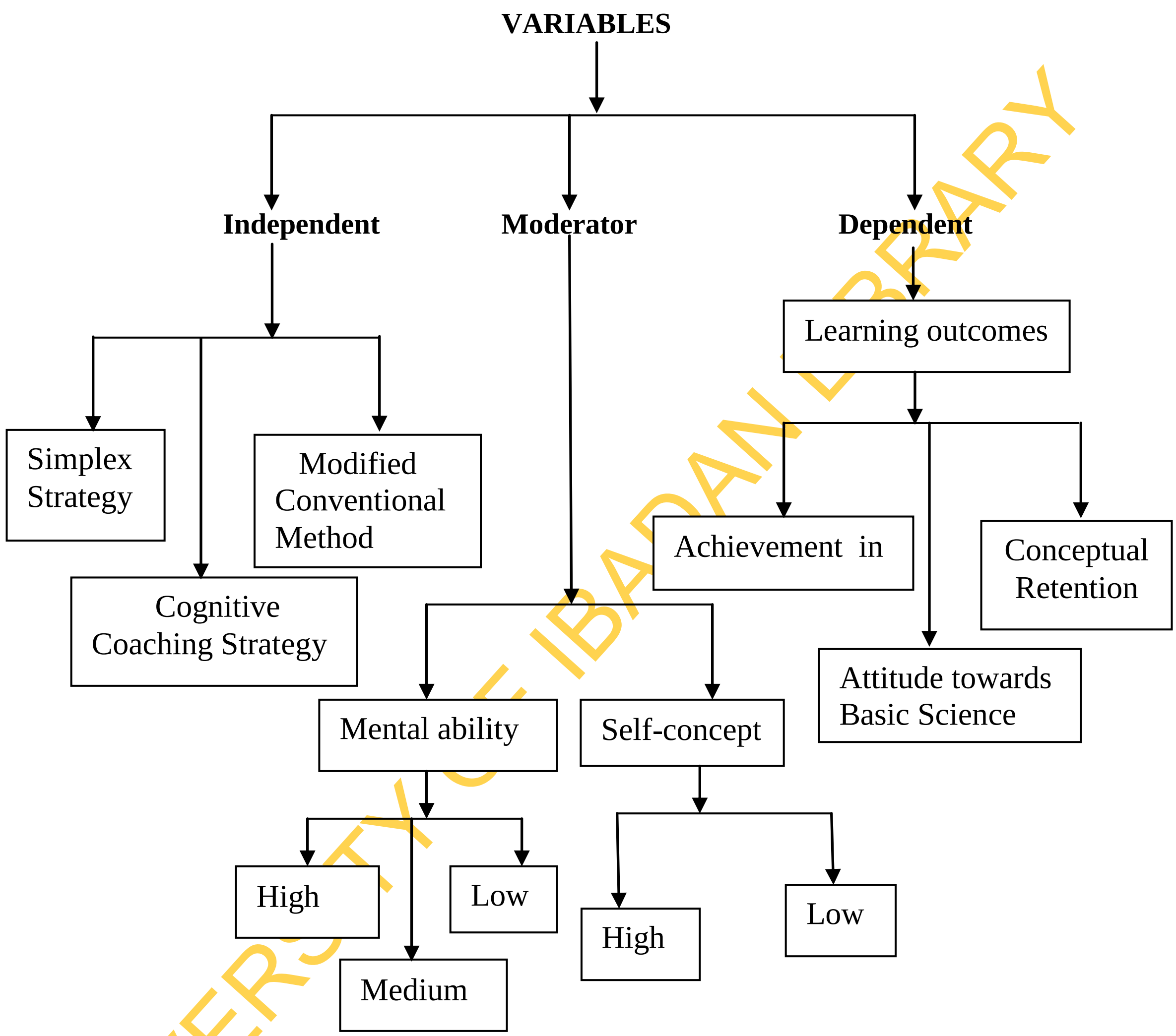

Fig 3.1: Chart showing the Variables of the Study.

3.3 Sampling Procedure and Samples

A multi-stage sampling procedure was adopted. Kwara State has been stratified into three zones along the axis of the existing senatorial districts: Kwara North, Kwara Central and Kwara South. One of the districts was randomly selected.

A simple random sampling procedure using lot casting was adopted in selecting 3 local government areas from the district selected. All schools that met the criteria below were qualified for selection for the study:

(i). Schools that have science laboratories;

(ii). Schools with qualified Basic Science teachers;

(iv). Co-educational schools;

(v). Schools that have presented students for Junior Secondary Certificate Examination (JSCE) at least from 2001.

Six schools were then randomly selected from the three local government areas (two from each). This was done by simple random selection of any of the numbers assigned to all the schools by replacement one at a time and were assigned to treatment accordingly. Two intact JSS II classes were involved in each group in this study. Two hundred and twenty-three students made up of male and female participated in the study. Eighteen students (six students from each group) were selected based on their levels of mental ability categorization and participated in the debriefing protocol before and after the treatment of each concept.

3.4.0 Research Instruments

Eight instruments were developed and are sub-divided into stimulus and response instruments. The response instruments were used for gathering data in this study. They include:

(i). Teacher's Instructional Guide for Simplex Strategy (TIGSS);

(ii). Teacher's Instructional Guide for Cognitive Coaching Strategy (TIGCCS);

(iii). Teacher's Instructional Guide for Modified Conventional Method (TIGMCM);

(iv). Basic Science Concepts Achievement Test (BSCAT);

(v). Attitude Towards Basic Science Scale (ATBSS);

(vi). Mental Ability Test (MAT);

(vii). Self-Concept Inventory (SCI);

(viii) Basic Science Conceptual Change Debriefing Protocol (BSCCDP).

(A) Stimulus Instrument

3.4.1.1 Teacher's Instructional Guide for Simplex Strategy (TIGSS)

Teacher's Instructional Guide for Simplex Strategy (TIGSS) outlines the steps involved in presenting the course content to the students' in Simplex group (Experimental group 1).

Step I: Introduction:- Teacher:

(i) takes attendance;

(ii) writes the topic on the chalkboard;

(iii) states the instructional objectives.

Step II: Presentation:- Teacher:

(i) asks questions to discover students' prior understanding of a concept;

(ii) presents information on the topic inform of definition;

(iii) groups students' consisting of 5 members each and supplies them with flash cards.

Step III: Strategy Implementation:-

(i) teacher asks relevant questions to initiate learning about a concept;

(ii) students' contribute facts and ideas;

(iii) teacher defines the concept and tells students' to write them down.

Step IV: Students' Activities:- Students':

(i) form groups of 5 each;

(ii) write main ideas on flash cards;

(iii) select and arrange the relevant facts orderly;

(iv) state outlined procedure for carrying out an investigation on the concept;

(v) agree to use specific procedure;

(vi) verify the right concept based on steps I, II and III under teacher's supervision.

Step V: Evaluation:- Teacher:

(i) asks questions on concept investigated;

(ii) identifies procedures;

(iii) scores steps;

(iv) asks oral questions and moderates students' responses;

(v) gives follow-up activities.

Students' raise questions and list new knowledge gained.

3.4.1.2 Validation of TIGSS

The TIGSS draft was presented to five experienced science teachers to assess the suitability of its procedure for classroom instruction. Their suggestions were effected where necessary for refinement of the guide and was used by two science teachers to teach two different groups made up of fifty students similar to the sample. Each group carried out the implementation twice during which three science teachers rated the adequacy of the guide as indicated below in terms of:

(a) ease of use = 5;

(b) consistency in following steps in the guide = 10;

(c) compliance with time allocated to each step = 5;

(c) effectiveness of use of guide in covering content for each lesson = 10.

These comments were analysed for congruence and their inter-rater reliability coefficient using Scott's π was found to be 0.80.

3.4.2.1 Teacher's Instructional Guide for Cognitive Coaching Strategy (TIGCCS)

Teacher's Instructional Guide for Cognitive Coaching Strategy (TIGCCS) indicates the steps involved in presenting the course content to the students' in Cognitive Coaching group (Experimental group 2).

Step I: Introduction:- Teacher:

(i) takes attendance;

(ii) writes the topic on the chalkboard;

(iii) states the instructional objectives.

Step II: Presentation:- Teacher:

(i) asks questions to discover students' prior understanding of a concept;

(ii) notes students' prior understanding on the board.

Step III: Strategy Implementation:- Teacher:

(i) initiates verbal rapport by leading a discussion on students' prior understanding;

(ii) asks questions requiring students' to express their views freely;

(iii) tells students' to form groups of three each.

Step IV: Students' Activities:- Students':

(i) form groups of 5 each;

(ii) think and communicate ideas about the concept (topic);

(iii) read and reflect on a passage from text;

(iv) write down main ideas about the passage;

(v) identifies discrepant events or ideas;

(vi) seek clarification and accommodate new ideas.

Step V: Evaluation: - Teacher:

(i) asks questions and leads a discussion on the concept investigated;

(ii) summarizes students' plan of activity on the board;

(iii) students' swap work for scoring;

(iv) gives follow-up activities.

Students' raise questions and list new knowledge gained.

3.4.2.2 Validation of TIGCCS

A copy of TIGCCS draft was presented to each of five experienced science teachers in order to evaluate its quality for classroom teacher-students interaction. The modified copy was trial tested on two different groups of fifty students of similar characteristics as the sample. This exercise was repeated again on each group and experts assisted to pass comments on and rated the:

(i) convenience of use = 5;
(ii) coherent with steps in the guide = 10;
(iii) capability to manage time allocated to each step = 5;
(iv) appropriate use of guide to cover the content for each lesson = 10.

The ratings obtained from this exercise were used to estimate the inter-rater reliability of the instrument and a reliability index of 0.75 was obtained through the Scott's π method.

3.4.3.1 Teacher's Instructional Guide for Modified Conventional Method (TIGMCM)

Teacher's Instructional Guide for Modified Conventional Method (TIGMCM) describes the steps involved in presenting the course content to the students' in the Modified Conventional Method group (Control group).

Step I: Introduction:- Teacher:

(i) takes attendance;
(ii) writes the topic on the chalkboard;
(iii) states the instructional objectives.

Step II: Presentation:- Teacher:

(i) asks questions to discover students' prior understanding of a concept;
(ii) links new lesson with previous knowledge;
(iii) defines the concept.

Step III: Strategy Implementation:- Teacher:

(i) describes a given concept;

(ii) leads discussion on the concept and gives examples;

(iii) demonstrates using charts or diagrams and asks questions;

(iv) gives chalkboard summary.

Step IV: Students' Activities:- Students':

(i) respond to teacher's questions;

(ii) write down the chalkboard summary in their notebook.

Step V: Evaluation:- Teacher:

(i) checks students' so that they copy note;

(ii) asks questions on the topic and reinforces students' correct responses;

(iii) gives follow-up activities.

Students' list new knowledge gained.

3.4.3.2 Validation of TIGMCM

The TIGMCM draft was also made available to five experienced science teachers in order to consider its adaptability for classroom activities. Slight changes were made in line with the input of the science teachers for it to be suitable for classroom instruction. The adjusted copy was trial tested twice on fifty students each of two different groups equivalent to the sample. Three science educators offered contributory ratings based on:

(i) its usability = 5;

(ii) logicality in following the steps in the guide = 10;

(iii) adequacy in time management on each step = 5;

(iv) conformity with the use of guide to cover the content for each lesson = 10.

From this procedure, the inter-rater reliability was ascertained using Scott's π method. This yielded 0.85 reliability index.

Response Instruments

3.5.1.1 Basic Science Concepts Achievement Test (BSCAT)

This contained a test of students' cognitive achievement on selected Basic Science concepts. It was drafted by the researcher based on the selected Basic Science concepts. The selection of items and the allocation of questions to the three levels of cognitive domain considered here were worked out mathematically based on the criteria: (i) length of time for teaching each concept, and (ii) nature of lesson objectives stated in the course book. BSCAT was made up of thirty multiple-choice items with four alternatives (A to D). The proportions of test questions for each of the concepts were evenly distributed. Eleven items on knowledge enabled the recall of specific concepts by the students'. Ten items on comprehension showed students' understanding and interpretation of information or concepts, where as nine items on application involved making use of knowledge of rules to find solutions to problems or for better conceptualization of the concepts learnt. The table of specification for BSCAT on the concepts learnt in this study is as presented in table 3.2. The questions on all the four selected Basic Science concepts were mixed up in the paper to allow for diversity in students' thinking.

Table 3.2: Table of specification of items in BSCAT

Level	Concepts				Total
	Habitats	Rusting	Energy	Simple machine	
Knowledge	5, 30, 28	2, 20, 25	21, 23, 29	1, 14	11
Comprehension	8, 27	9, 11, 15	6, 17	4, 13,22	10
Application	10, 19	16, 24	3, 12, 26,	7, 18	9
Total	7	8	8	7	30

3.5.1.2 Scoring of BSCAT

Each item on BSCAT was allotted a mark. The items were scored manually by the researcher. Any item not answered correctly was scored zero where as those items that were answered correctly were scored 1 mark each. Thus, the achievement of each participant was rated upon 30 marks. The scores obtained by the students from BSCAT reflected the achievement of students in each level. The BSCAT used in this study is contained in Appendix V.

3.5.1.3 Validity and Reliability of BSCAT

The researcher constructed fifty multiple choice items using the table of specification to make up the BSCAT. A copy each of table of specification and BSCAT were presented to three Science teachers at the secondary school level, one lecturer at the Science department of a College of Education as well as to a University Science Educator for review. The aim was to fine-tune the suitability of the test for the targeted population. Their input was used to reduce the number of the items to thirty and was trial tested on twenty JS 2 students in two schools (twenty five each from Baptist comprehensive college and Model secondary school in Kontagora,) of similar characteristics as the sample for this study. The response of the students was subjected to item analysis and internal consistency using Kuder Richardson formula 20 (KR-20). An average difficulty index of 0.54 was obtained indicating that the test was of moderate level of difficulty. Also a reliability index of 0.73 was obtained.

3.5.2.1 Basic Science Conceptual Change Debriefing Protocol (BSCCDP)

The constructed BSCCDP was adapted from Trundle, Atwood and Christopher (2007) based on the course contents of the selected Basic Science concepts for this study. It comprised short structured tasks which students were expected to reason and respond verbally to in order to find out their level of conceptual understanding of the selected concepts. Four tasks each were stated under each concept. Students' responses were coded qualitatively as:

Whole conceptions: when there are complete scientific ideas,

Partial conceptions: when there are traces of scientific knowledge,

Opposite conceptions: when misconceptions are identified and

No response: when there is no idea of any kind.

A coding sheet was used for coding students' responses from replayed audio-video-recorded debriefing. A coding sheet was used for each student bearing his or her name and school with a portion for the type of response coded (Appendix VI).

3.5.2.2 Scoring of BSCCDP

The researcher sorted out the frequency of each of the conceptions from students responses. This was used to ascertain the level of improvement exhibited in conception of science concepts by students.

3.5.2.3 Validity and Reliability of Basic Science Conceptual Change Debriefing Protocol (BSCCDP)

The adapted BSCCDP was presented to five science teachers for comments on its suitability. This was thereafter tested on five students and three science educators were requested to code students responses from a transcribed recorded video clips. The frequency of their codings were rated and an inter-rater reliability was obtained through Scott's π method. This produced 0.67 reliability index.

3.5.3.1 Attitude Towards Basic Science Scale (ATBSS)

Attitude Towards Basic Science Scale (ATBSS) was constructed by the researcher to measure the attitude of students' towards Basic Science based on selected Basic Science concepts. The instrument consists of two sections (A and B). Section A of the instrument sought to obtain background information such as:

School,

Name of Student,

Class and

Age from the respondents.

Section B of the instrument consists of 20-item statements reflecting the affective domain on students' feelings, interests, beliefs, values, etc, towards selected Basic Science concepts on a four point Likert Scale of strongly agree, agree, disagree and strongly disagree, (Appendix VII). The respondents were required to tick just one appropriate option. The attitude areas itemized in ATBSS are as presented in table 3.3.

Table 3.3: Distribution of Items on ATBSS According to Attitude Area

S/N	ATTITTUDE AREA	ITEM NUMBER ON SCALE	TOTAL
1.	Interest in Basic Science.	4, 9, 10, 14, 18.	5.
2.	Attitude to subject area.	1, 2, 8, 11, 12, 13.	6.
3.	Perceived benefits of Basic Science and future prospects.	5, 6, 7, 19, 20.	5.
4.	Knowledge of Basic Science.	3, 15, 16, 17.	4.
	Total	20	20.

3.5.3.2 Scoring of ABTSS

The first ten positively worded items on ATBSS were weighted as stated below:

Strongly Agree (SA) = 4

Agree (A) = 3

Disagree (D) = 2

Strongly Disagree (SD) = 1

While the other ten items negatively worded were weighted in the reversed order, ie,

Strongly Agree = 1,

Agree = 2,

Disagree = 3 and

Strongly Disagree = 4.

The scoring of items on ATBSS was done by the researcher.

3.5.3.3 Validity and Reliability of Attitude Towards Basic Science Scale (ATBSS)

The constructed ATBSS was presented to each of three science educators for content validity review in terms of: use of language, ideas portrayed, applicability, etc. The construction of some of the items was corrected as proposed by the expert reviewers. The resulting copy was trial tested on fifty JS 2 students of Baptist comprehensive college and Model secondary school in Kontagora, similar to the sample of this study. The responses of the respondents were subjected to analysis and the reliability estimated using Cronbach alpha formula from which the reliability coefficient of 0.83 was obtained.

3.5.4.1 Mental Ability Test (MAT)

The MAT was a psychology test and it was used to measure how well a student can think. It was adapted from Bamidele (2000) in the pattern of Stanford-Binet Intelligence Scale (1916). It covered questions from different kinds of concepts that require critical brainstorming. This was meant to reveal certain information in the process of understanding and development of students at junior secondary level. The instrument was made up of sections A and B. Section A solicited for student's identity, while section B contained twenty questions aimed at detecting students general knowledge on possible likeness about objects, relationships about objects and meaning of concepts (Appendix VIII). This was meant to categorize students into the levels of mental abilities. The categorization was done by computation of the semi-interquatile range that provided a numerical index of half of the scores between the first quartile (Q_1 = 5, ie, 25th percentile) and the third quartile (Q_3 = 15, ie, 75th percentile) in the scores. The median of the scores was obtained to be 9 and the semi-interquartile range (SIQR) was determined to be 5. Thus, the 50% of the scores in the distribution fell between 4 and 14 (ie, 9 $\pm$ 5). As a result, students that scored below 4 were grouped as possessing low mental ability, those that fell between 4 and 14 were grouped as having medium mental ability whereas those that scored above 14 were categorized as having high mental ability.

3.5.4.2 Scoring of MAT

The scoring of MAT for which each question carried 1 mark was done manually by the researcher, thus each student was rated on 20 marks. The students scores were subjected to percentile ranking which revealed the percentage of students in the standardization sample falling above or below the group mean was obtained and used to set specific ranges for determining mental ability as: low, medium and high respectively.

3.5.4.3 Validity and Reliability of Mental Ability Test (MAT)

The researcher constructed thirty items and was presented to three Psychologists (two in a College of Education and one in a University) for content validity review in term of skills reflected and applicability to the JS 2 students' level. Their suggested views necessitated the reduction of the number of the items to twenty. It was trial tested on fifty students each from Baptist comprehensive college and Model secondary school in Kontagora. The difficulty index was obtained to be 0.48 while its reliability index gave 0.67 using Kuder Richardson 20 (KR 20).

3.5.5.1 Self-Concept Inventory (SCI)

Self-Concept Inventory was constructed by the researcher purposely to determine how students perceive self in and out of Basic Science environment. It showed the general student tendencies to regard each self as an object. The format of Self-Concept Inventory that was used for this study was an adapted type from Aremu (1997). It contained 20-item statements on perception of self (10 positively and 10 negatively worded). The inventory was made up of two sections: A and B. Section A requested students' identity while section B requested a tick response from students to strongly agree, agree, disagree or strongly disagree with the statements on habits that may be displayed by each student as identified among others (Appendix IX).

3.5.5.2 Scoring of SCI

The response of students to Self-Concept Inventory was weighted from 4 to 1 for high and 1 to 4 for low categories respectively. That is, for items on high self-concept:

Strongly Agree = 4,

Agree = 3,

Disagree = 2 and

Strongly Disagree = 1;

while for items on low self-concept:

Strongly Agree = 1,

Agree = 2,

Disagree = 3 and

Strongly Disagree = 4.

3.5.5.3 Validity and Reliability of Self-Concept Inventory (SCI)

The thirty-item Self-Concept Inventory draft that covered high as well as low aspects of 'self' was presented to three Guidance and Counseling experts in Colleges of Education for content validation. Their comments served as guiding principle for deleting some items in order to reduce the number to twenty items. This was then a administered on fifty JS 2 students, from Baptist comprehensive college and Model secondary school in Kontagora. The reliability of the instrument was determined using Split-half method and a value of 0.79 was obtained.

3.6 Procedure for Data Collection

The researcher, with the teachers (Basic Science teachers) trained for this study participated in data collection through a pretest, pre-treatment debriefing, treatment, post-treatment debriefing, posttest, delayed debriefing and delayed posttest administration. The randomly selected schools as indicated under sampling procedure and samples (3.3) were visited by the researcher, the principals of the schools were consulted for permission, and the teachers were trained adequately. All the students in the three groups who participated in this study were pre-tested with the use of all the response instruments.

With the assistance of the teachers, Attitude Towards Basic Science Scale (ATBSS) was administered first. Each of the three groups was therefore exposed to the treatment selected for it. The post-test which contained the same items used as pre-test was administered on all the groups at the end of the treatment sessions. The fieldwork was scheduled as follows:

One week was scheduled for training the teachers and a week for pretest administration in December 2009. Starting from early part of January 2010, sixteen weeks were scheduled for treatment and debriefing implementation and a week for post-test administration immediately after the treatment. This was necessary because the schools normal activities were affected somehow by the study. In addition, eighteen students participated in the conceptual change debriefing protocol before and after been exposed to each of the concepts. Six students each were selected based on those categorized as having high, medium or low mental ability respectively from the schools in each group for the debriefing protocol. The researcher coded each student's responses. All the sessions were video recorded. A delayed debriefing protocol using BSCCDP and delayed post-test using the BSCAT were administered on the groups four weeks beyond the intervention. This was carried out in order to ascertain the extent to which the students were able to retain the concepts learned in the selected Basic Science concepts due to the interventions employed in the course of this study.

3.7.1 Training of Teachers

The researcher organized a one day seminar for the teachers engaged in this study. The aim of the seminar was to acquaint the teachers with the technicalities involved in the task they were to carry out. All the Basic Science teachers in the six selected schools were invited to participate in the training seminar at Government Junior Secondary School Jebba. The teachers were lectured on the importance of identifying students' prior-knowledge for conceptual change. Thereafter, they were disengaged into their respective groups for specific training procedure. The teachers were instructed and allowed to study the course contents, the instructional guides and the lesson notes.

3.7.2 Phase 1: Training of Teachers based on group

The researcher visited each of the six randomly selected schools, and after due consultation with the school principal, the teachers concerned were engaged and guided on how to implement the strategy (Simplex, Cognitive Coaching and Modified Conventional Method) they were to use in teaching the contents of the selected Basic Science concepts. The researcher presented TIGSS, TIGCCS and TIGMCM to the group assigned for each respectively at different locations (Government Junior Secondary School, Jebba; Ja'amat Nasirul Islam Secondary School, Babanloma; Unity School, Kaiama) for a joint study and discussion with the teachers. This was followed by studying the procedure for the content treatment peculiar to the group each teacher fell into. The researcher taught a model lesson for each participating teachers to observe, to learn from and to familiarize themselves with the steps stated in the instructional guides. The teachers were allowed to practice the use of the content treatment procedure with some students while the researcher observed. The exercise was carried out in the second week in December 2009.

The teachers engaged in the experimental and control groups were trained accordingly in order to ascertain a high degree of within group uniformity among the categories of teachers that implemented the treatment. The procedure for training teachers is indicated in appendix I. Discussions were held according to the guidelines provided to the teachers as follows:

1. Use the conceptual question as an exposing event that helps students expose their conceptions about the specific concept.
2. Allow all students to make their own conceptions explicit.
3. Ask what students believe or think about the concept and why they think that way.

4. Write or draw students' ideas on the chalkboard even if they are not correct.
5. Be neutral during the discussion. If students give the correct answer, take it as another suggestion.
6. Be patient. Give enough time for students to think and respond to the questions.
7. Ask only descriptive questions to uncover what students really think about the concept.
8. Assist the students in stating their ideas clearly and concisely, by which they become aware of the elements in their own preconceptions.
9. Encourage confrontation in which students debate the pros and cons of their preconceptions and increase their awareness and understanding of the differences between individual preconceptions.
10. Encourage interaction among students.
11. Create a discrepant event, one that creates conflict between exposed preconceptions and some observed phenomenon that students cannot explain.
12. Let students become aware of this conflict; cognitive dissonance, conceptual conflict, or disequilibrium.
13. Help students to accommodate the new ideas presented to them.
14. Make a brief summary from beginning to the end of the discussion.
15. Show explicitly where oversimplification, exemplification, association and multiple representations have happened.
16. Give students the feeling of progress and growth in mental power and help them develop confidence in themselves and their abilities.

The teachers were provided a validated procedure for course content on the selected Basic Science concepts based on the treatment to be adopted and were regularly supervised during teaching. The validation of treatment conditions by the researcher was carried out to ensure that the conditions were not violated, thus maintaining a high level intra-teacher reliability (Fricks, 1980). The researcher strived harder in the study to prevent interaction and exchange of experience that may contaminate the treatment among students involved in the treatment groups by restricting each group to a local government.

3.7.3 Phase 2: Administration of Pre-test

Pre-test was administered immediately after the training of the teachers engaged in this study in December. All the students in each of the intact classes of the six randomly selected schools in the three groups that participated in this study were pre-tested with the use of all the response instruments. With the assistance of the Teachers, ATBSS was administered first in order to overcome the influence which other instruments could have on the students' dispositions to Basic Science.

3.7.4 Phase 3: Treatment Stage

The teachers were made to carry out the treatment using the course content treatment procedures specified for each group. Students were exposed to the main Basic Science concepts selected for the study. The three instructional strategies were assigned each to the groups as previously determined by purposive sampling. The treatment phase covered sixteen weeks during which nine lessons were taught each on the four concepts and followed with a review. A conceptual change debriefing protocol was conducted before and after the treatment on each concept selected. The whole stage was carried out as highlighted below:

-Familiarisation with intact classes involved was conducted in the first week of second term in January.

-Pre-treatment debriefing protocol was conducted in the second week to register students' conceptions on the first concept (Habitat).

-The treatment on the two lessons on habitat was carried out in the third week.

-Review and post-treatment debriefing protocol on habitat were conducted in the fourth week.

-Pre-treatment debriefing protocol on the second concept (Rusting) was conducted in the fifth week.

-Treatment on rusting was carried out by the sixth week.

-A review as well as post-treatment debriefing protocol on rusting was conducted in the seventh week.

-Mid-term break: eight and ninth week.

-Pre-treatment debriefing protocol on the third concept (Energy) was conducted in the tenth week.

-Treatment on Energy was carried out in the eleventh week.

-The review and post-treatment debriefing protocol on energy were conducted in the twelfth week.

-Pre-treatment debriefing protocol on the fourth concept (Simple machine) in the thirteenth week (ie, first week of third term).

-Treatment on Simple machine was carried out in the fourteenth week.

-A review and a post-treatment debriefing protocol on simple machine were conducted in the fifteenth week.

-An overall revision of the course contents selected for this study was carried out in the sixteenth week.

All the debriefing protocols were video recorded to ease analysis on conceptual change on the selected Basic Science concepts in this study.

3.7.4.1 Experimental Group 1: Simplex Strategy (SS)

This group used Simplex strategy for conceptual change on selected Basic Science concepts. The teacher gave the fundamental expectations on Simplex Strategy. These expectations include: topic finding, fact finding, concept definition, idea finding, evaluation and selection, action planning, gaining acceptance, and taking action (Appendix II). The approach followed the steps as:

(i) Begin with an initial statement of the topic which may be incomplete or ill-defined in small groups of 5 each.

(ii) Connect topic finding with fact finding.

(iii) Form connection between fact finding and solution finding by framing each concept as a challenge.

(iv) Generate a wide range of possible ideas on flash cards.

(v) Generate criteria for the selection of the ideas with the most desirable solution.

(vi) Generate an action plan by identifying what to be done, by whom, when, where and how.

(vii) Agreeing that the procedure simplifies the desire to understand a scientific concept.

(viii) Carrying out follow-up activities.

The Simplex group learned the contents of the selected Basic Science concepts within sixteen weeks. The students were directed to state facts, ideas on flash cards, select salient ideas, carry out planned procedure for investigating a concept and were marked by the teacher at the end of the lesson. Teacher's assessment format is contained in Appendix XA.

3.7.4.2 Experimental Group 2: Cognitive Coaching Strategy (CCS)

The group used cognitive coaching strategy for conceptual change on selected Basic Science concepts (Appendix III). The coach (teacher) created a rapport on the use of Cognitive coaching. The teacher stressed the guiding principles in using cognitive coaching strategy as:

(a) Building trust by developing physical and verbal rapport in small groups of 3 each.

(b) Facilitating thinking through questioning and developing greater precision in language.

(c) Developing student's autonomy through facts finding from texts.

(d) Monitoring one's thoughts and their effects.

(e) Discussing one's finding with others that are congruent with the concept learned.

(f) Reinforcing skills which enhance the intellectual processes of performance.

Students were supplied with textbooks to work with under direct instruction from the teacher. Students wrote their discoveries. Corrections were made and students swapped work for scoring and carried out follow-up activity. The contents of the Basic Science concepts selected for this study were learned by the students in the Cognitive Coaching group. The students were directed to create rapport, trust, mediate questions, respond behaviourally, pace and lead convincing discussions with the teacher moderating. The exercise was carried out through sixteen weeks. Teacher's assessment format is contained in Appendix XB.

3.7.4.3 Control Group: Modified Conventional Method (MCM)

This group was deliberately and particularly not allowed to experience any of the innovations imbedded in the experimental groups. The Modified Conventional Method was used to teach the Control group as outlined in the instructional procedure for selected Basic Science concepts. The method required the teacher to introduce the concepts to be learnt, made connection of new concept with previous concept, gave explanation of major ideas; showed charts, discussed ideas and gave questions. The students listened to teacher's explanation, observed charts and responded to questions. Students wrote down the summary of the lesson and did assignments. The period for this interaction also covered sixteen weeks, (Appendix IV). The assessment format for teachers is contained in Appendix XC.

3.7.4.4 Post Test

The post test was carried out using the same response instruments that were administered as pretest. These were administered on all the groups at the end of the treatment sessions. These instruments include:

(a) Attitude Towards Basic Science Scale (ATBSS).
(b) Mental Ability Test (MAT)
(c) Self-Concept Inventory (SCI).
(d) Basic Science Concepts Achievement Test (BSCAT).
(e) Basic Science Conceptual Change Debriefing Protocol (BSCCDP).

The items in each of the instruments used for pretest were rearranged before it was used for the post-test. This was necessary in order to prevent halo-effect that may ensue due to knowledge of pretest.

3.7.4.5 Delayed Post Test

The researcher revisited the schools after four weeks from post-test administration (i.e, 9^{th} week of third term), a debriefing protocol was carried out on all the concepts on the earlier selected eighteen students from all the groups and with the assistance of the Basic Science teachers, BSCAT was administered again on all the students in order to ascertain the level of retention exhibited by the students.

3.8 Data Analysis

Both the descriptive and inferential statistics were used for analyzing the data gathered in this study. The research questions in this study were addressed qualitatively based on the coded responses of students from a debriefing protocol on the selected Basic Science concepts. Analysis of Covariance (ANCOVA) (which helped to test the significant difference between mean scores; takes care of the effect of the independent variables on dependent ones and one or more covariates; adjusts initial difference in the experimental group and reduces the effect of extraneous variations in the pre and post test measures) was used to test the hypotheses and the differences among the groups using the pre-test scores as covariates. Multiple Classification Analysis (MCA) was used to identify the performance of each group. Scheffe multiple range test was used for post hoc analysis to determine the source of the significant main effect. All the hypotheses were tested at p <

.05 level of significance. Also, graphs were used to explain the frequencies of types of students conceptions and the interaction effect of variables where they occurred.

CHAPTER FOUR

RESULTS

This chapter presents the analysis of data and results with respect to the two research questions and the seven hypotheses tested in this study.

4.1 Research Questions

4.1.1 What pattern of conceptual change would be exhibited on Basic Science concepts by the targeted students when they are exposed to conceptual change (Simplex and Cognitive Coaching) strategies?

Table 4.1 presents the summary of the frequencies of types of conceptual understanding exhibited by students in Basic Science as revealed from the replay of recorded video CD of the Basic Science conceptual change debriefing protocol.

Table 4.1: Frequencies of Responses Indicating Types of Conceptual Change Pattern of Basic Science Concepts Exhibited by Students on Task Basis

Concept	N	Task	Whole		Partial		Opposite		No Response	
			Pre	post	pre	post	pre	post	pre	post
Habitat (Bio)	18	1	1	4	6	12	7	-	4	2
		2	8	15	4	3	4	-	2	-
		3	1	4	1	4	9	5	7	5
		4	-	1	1	3	4	7	13	7
Rusting (Chem)	18	1	3	11	7	4	7	2	1	1
		2	2	14	3	1	8	1	5	2
		3	-	4	2	6	8	4	8	4
		4	1	6	9	5	5	4	3	3
Energy (Phy)	18	1	4	10	4	3	6	4	4	1
		2	3	11	3	3	8	2	4	2
		3	4	6	4	9	7	1	3	2
		4	3	8	2	4	5	3	8	3
Simple Machine (Phy)	18	1	3	9	2	4	4	1	9	4
		2	12	17	3	-	2	1	1	-
		3	-	4	6	9	7	3	5	2
		4	1	13	4	-	4	4	9	1

Table 4.1 reveals the frequencies of students (18) responses during the debriefing protocol based on **Whole conceptions**, when there are complete scientific ideas; **Partial conceptions**, when there are traces of scientific knowledge; **Opposite conceptions**, when misconceptions are identified and **No Response**, when there is no clue or idea of any kind for pre and post instructional intervention for each task of the four concepts. As a result, a frequency of 18 responses ranging from whole to no response was expected on each task. In order to explain the pattern of the conceptual change exhibited by the targeted students, figure 4.1 to 4.4 were presented.

Figures 4.1a, 4.1b, 4.1c and 4.1d reveal students responses frequencies for the four tasks on the first concept (ie, **Habitat**).

Task 1: With the aid of the chart provided, describe aquatic habitat.

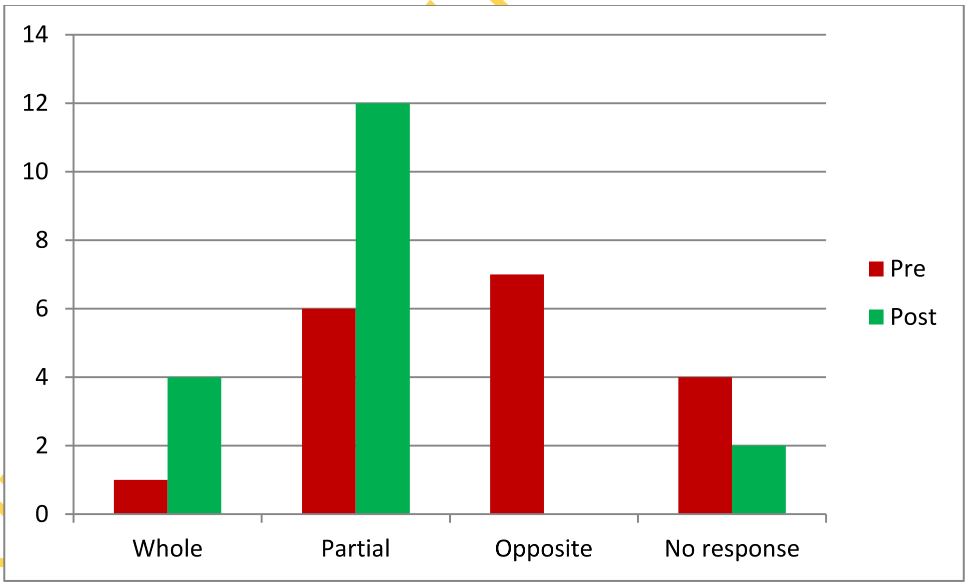

Fig 4.1a: Histogram of Students Pre and Post Intervention Conceptions on Task 1 of Habitat

Figure 4.1a shows that the targeted students improved upon their whole conceptions (frequency increased from 1 to 4) from pre to post treatment debriefing on the first task. While their partial conceptions built up, their opposite conceptions were totally resolved and their no response was reduced by half.

Task 2: Use the chart provided to identify and torch a biotic factor and an abiotic factor.

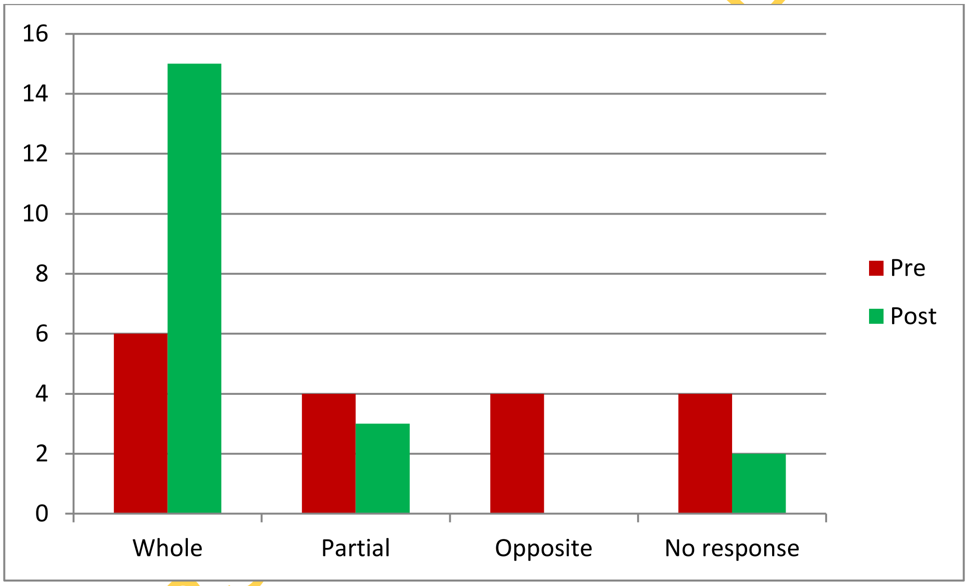

Fig 4.1b: Histogram of Students Pre and Post Intervention Conceptions on Task 2 of Habitat

Figure 4.1b indicates that, students whole conceptions of the second task received magnificent improvement from pre to post instructional debriefing. Though, partial conceptions of the task had a little turn over, the opposite conceptions as well as no response were altogether done away with.

Task 3: Explain population

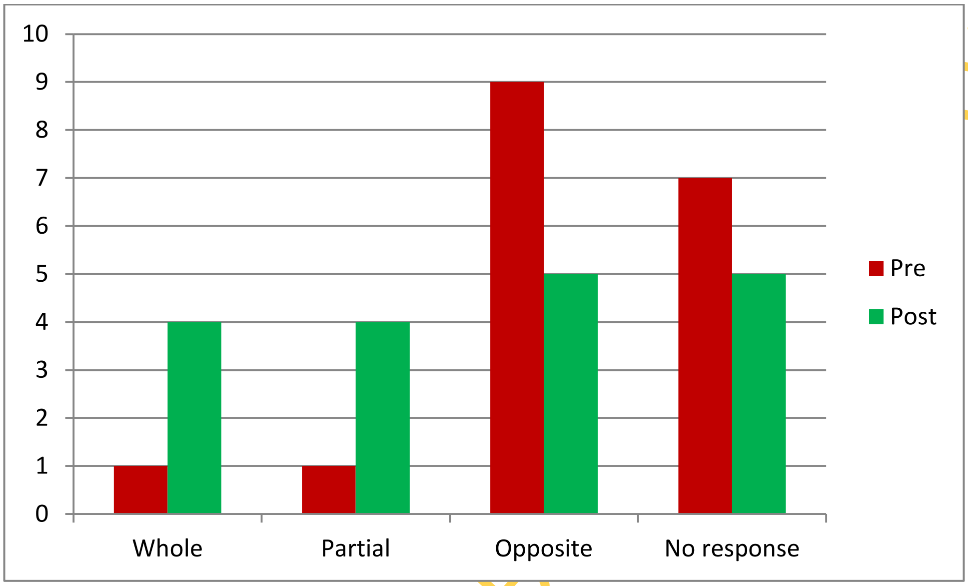

Figure 4.1c: Histogram of Students Pre and Post Intervention Conceptions on Task 3 of Habitat

Figure 4.1c reveals that the students conceptions of the third task received little adjustment. Students whole and partial conceptual responses were equally exhibited with a rise from 1 at pre to 4 at post instructional debriefing. Also, their opposite conceptions and no response frequencies were only a little lower at post than pre intervention debriefing respectively.

Task 4: What steps will you take to determine the population density of Grasshoppers on the school football field?

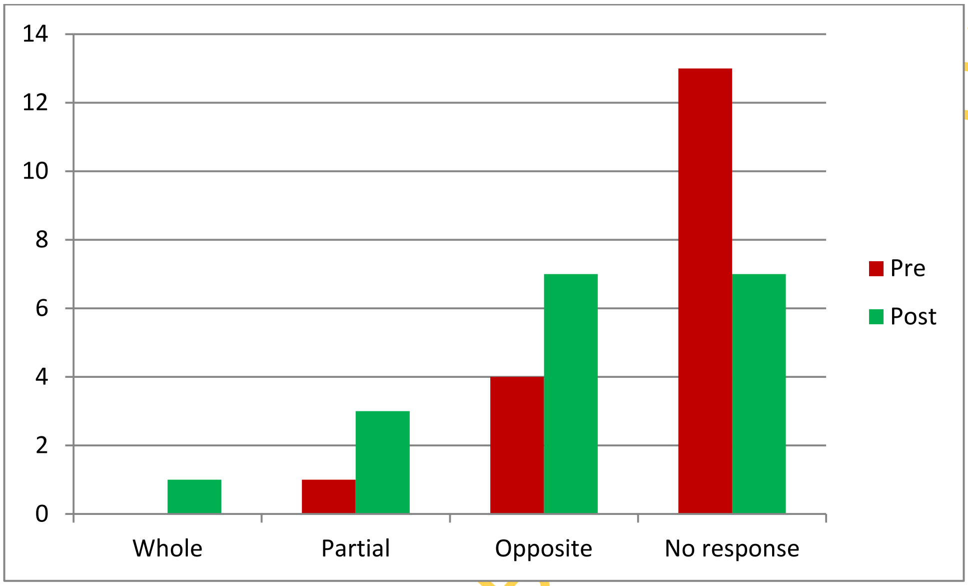

Fig 4.1d: Histogram of Students Pre and Post Intervention Conceptions on Task 4 of Habitat

Figure 4.1d indicates that students post intervention whole conceptions of the fourth task was very low. This conceptual pattern was similar to their partial conceptions. Although, their opposite conceptions built up, their was a reduction in their no response after the intervention.

Figures 4.2a, 4.2b, 4.2c and 4.2d reveal the targeted students types of response frequencies on the second concept (**Rusting**).

Task 1: Use the materials provided, describe the phenomenon shown by the objects.

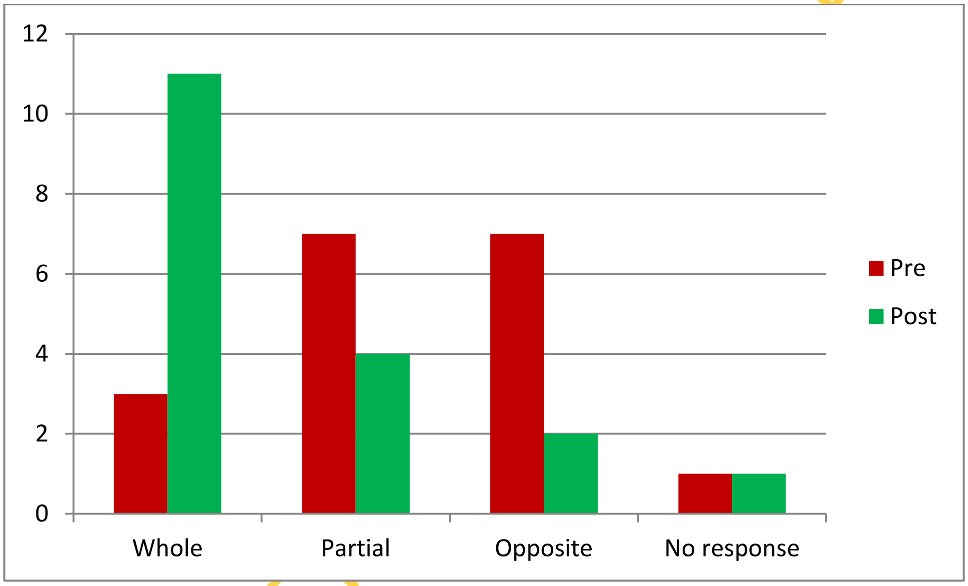

Fig 4.2a: Histogram of Students Pre and Post Intervention Conceptions on Task 1 of Rusting

Figure 4.2a shows that students whole conceptions built up significantly from pre to post intervention on the first task on rusting. It also reveals that partial and opposite conceptions dropped while no response remained the same from pre to post intervention debriefing.

Task 2: What are the factors/conditions responsible for the phenomenon?

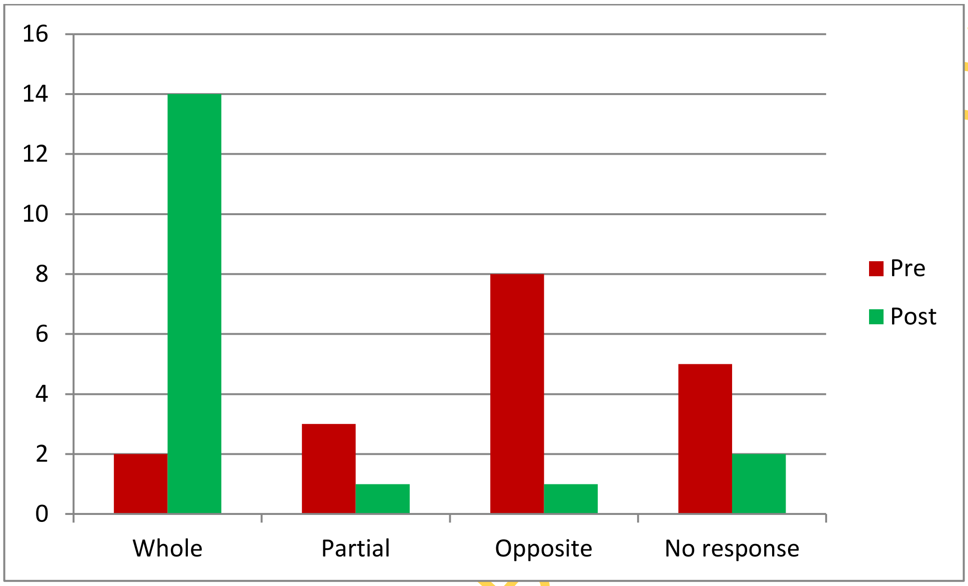

Figure 4.2b: Histogram of Students Pre and Post Intervention Conceptions on Task 2 of Rusting

Figure 4.2b indicates that students had significant conceptual understanding of the task as their whole conception increased in frequency drastically from pre to post intervention debriefing. The graph also shows that the partial and opposite conceptions as well as no response dropped noticeably.

Task 3: Why is it necessary to prevent the phenomenon?

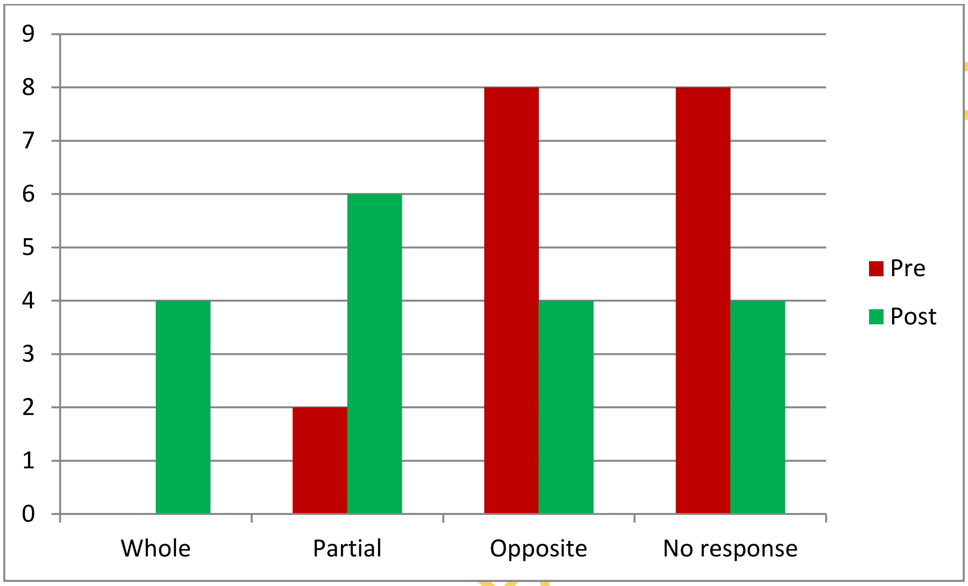

Fig 4.2c: Histogram of Students Pre and Post Intervention Conceptions on Task 3 of Rusting

Figure 4.2c shows that students whole conceptions increased substantially from non pre to 4 post intervention frequencies on the third task on rusting. The same pattern was shown in their partial conception from 2 pre to 6 post intervention frequencies. It also reveals that there were reduction in students opposite conceptions and no response from pre to post intervention debriefing.

Task 4: Scratch the matchbox with one of its sticks to light the candle provided. Observe for few seconds. Mention two differences between the phenomenon in 1, 2 and 3 and burning.

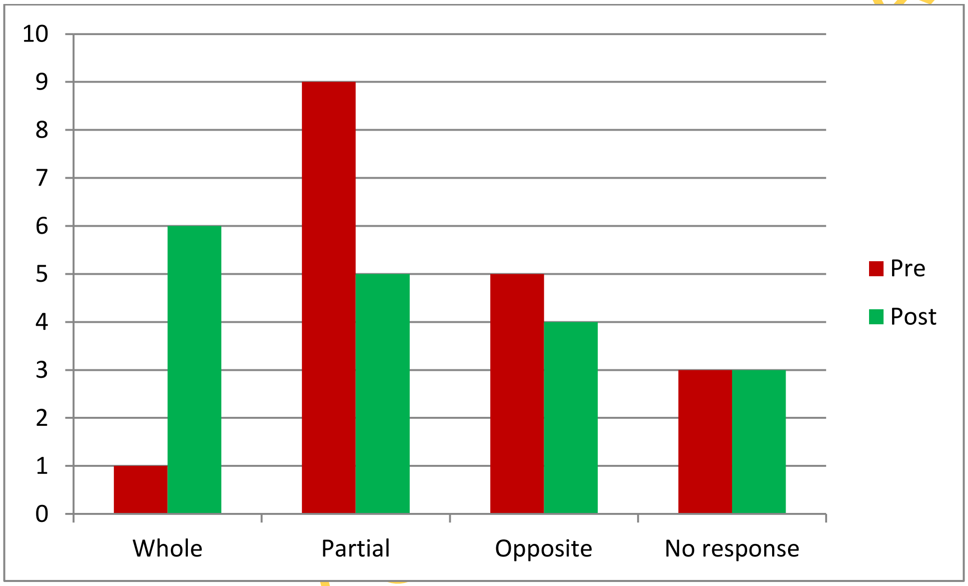

Fig 4.2d: Histogram of Students Pre and Post Intervention Conceptions on Task 4 of Rusting

Fig 4.2d indicates that students improved on their whole conceptions of task 4 on rusting significantly. Although, their partial and opposite conceptions dropped a bit, their was no difference in their no response frequency.

Figures 4.3a, 4.3b, 4.3c and 4.3d reveal the targeted students types of response frequencies on the third concept (**Energy**).

Task 1: You left your class for this debriefing, what enables you to do that?

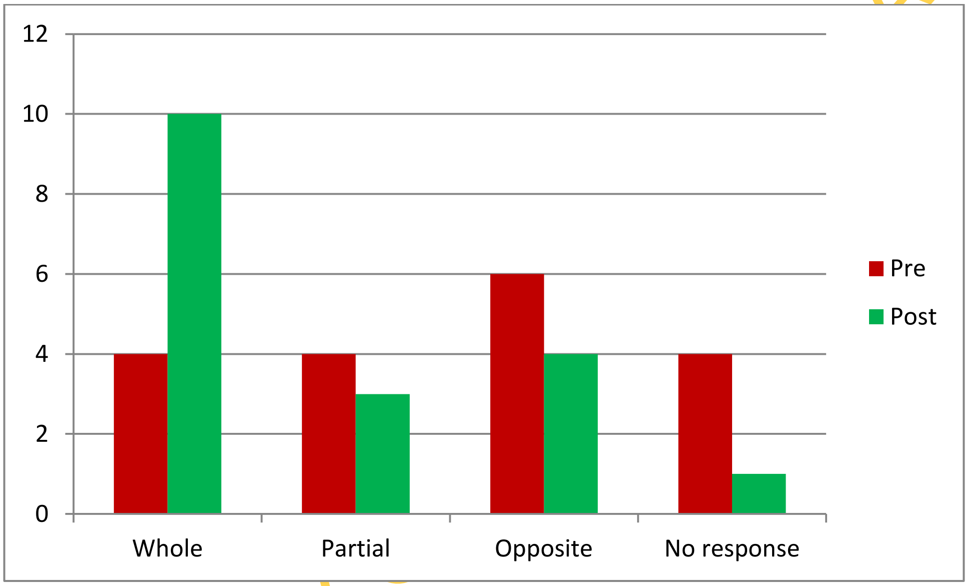

Fig 4.3a: Histogram of Students Pre and Post Intervention Conceptions on Task 1 of Energy

Figure 4.3a shows that students made significant whole conceptual understanding from pre to post intervention debriefing. Likewise, there were reductions in their partial and opposite conceptions as well as no response respectively.

Task 2: Examine the coarse/tainted louver glass supplied, why is it classified as translucent?

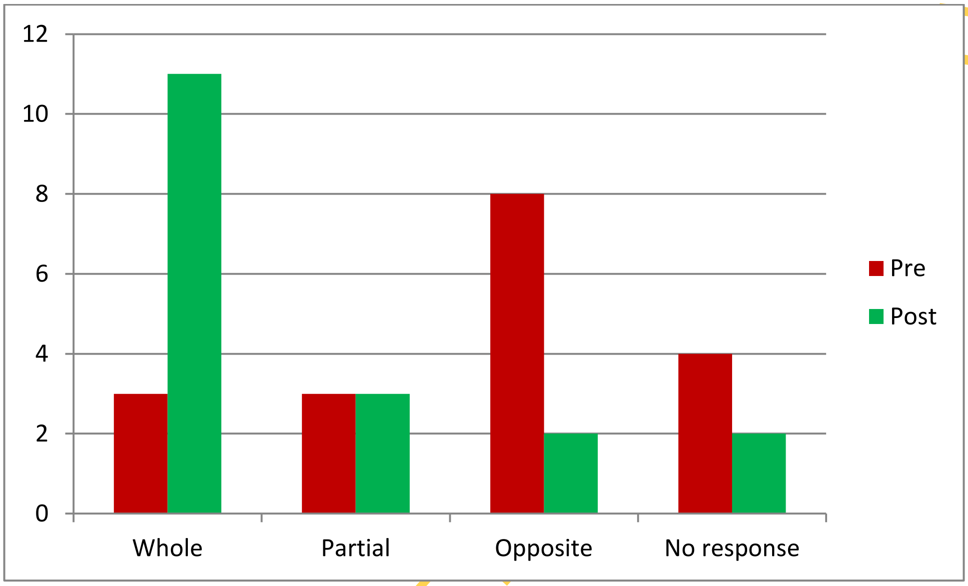

Fig 4.3b: Histogram of Students Pre and Post Intervention Conceptions on Task 2 of Energy

Figure 4.3b indicates that students whole conceptions about task 2 changed significantly from pre to post intervention. Although, there was no difference in students pre and post intervention partial conceptions, there were reductions in their opposite conception and of no response from pre to post intervention debriefing.

Task 3: Switch on the torchlight provided and direct the light to the shining surface of the standing plane mirror. Explain your observation.

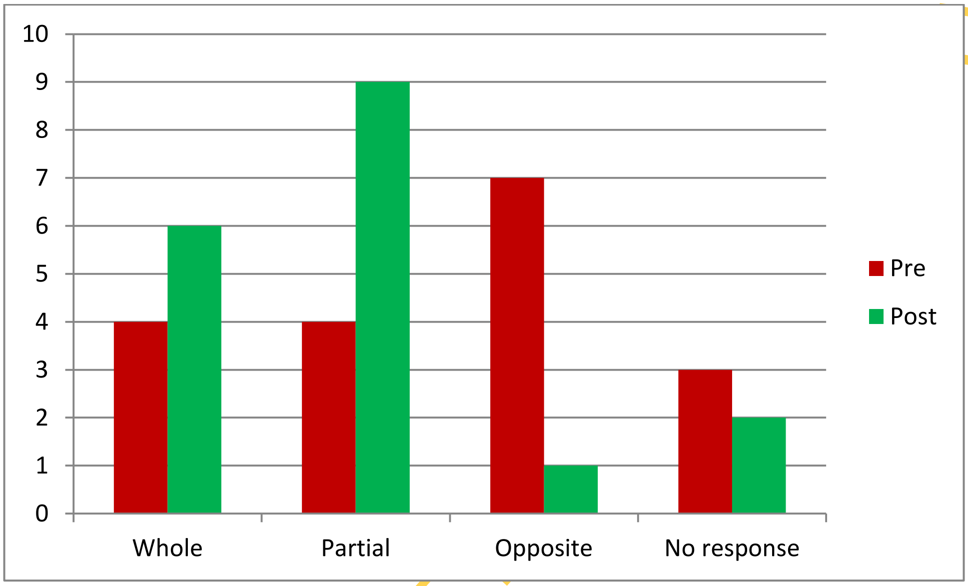

Fig 4.3c: Histogram of Students Pre and Post Intervention Conceptions on Task 3 of Energy

Figure 4.3c reveals that as students whole conceptions on task 3 built up, so it was for the partial conceptions from pre to post intervention debriefing. It also reveals that there were reductions in opposite conceptions and of no response from pre to post intervention debriefing.

Task 4: You use certain object(s) to produce light in searching for items at night, name the object and explain the type of energy conversion in it.

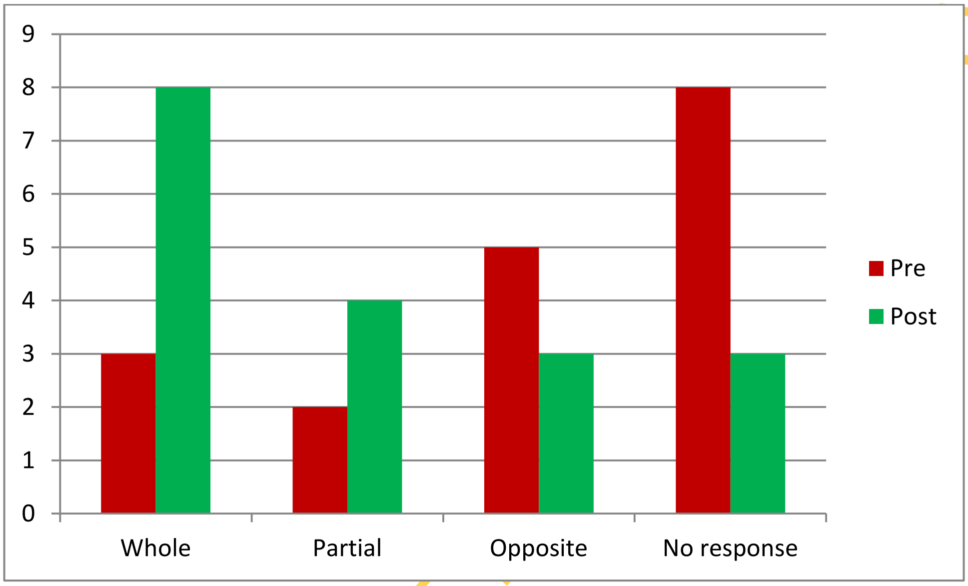

Fig 4.3d: Histogram of Students Pre and Post Intervention Conceptions on Task 4 of Energy

Figure 4.3d shows that both students whole and partial conceptions increased from pre to post intervention while their opposite conceptions and no response were reduced in frequencies from pre to post intervention debriefing respectively.

Figures 4.4a, 4.4b, 4.4c and 4.4d reveal the targeted students types of response frequencies on the fourth concept (**Simple Machine**).

Task 1: Examine the set ups A, B, C, carefully, which class of lever does B belongs?

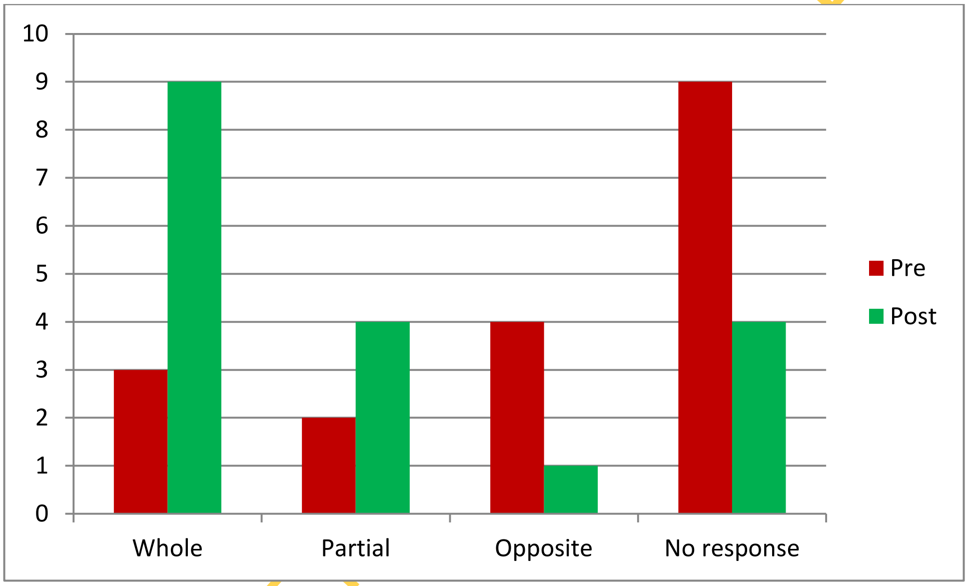

Fig 4.4a: Histogram of Students Pre and Post Intervention Conceptions on Task 1 of Simple Machine

Figure 4.4a shows that students whole conceptions increased from pre to post intervention just as their partial conceptions grew higher. However, it also reveals that the students opposite conceptions dropped prominently just as no response also dropped down on the first task on simple machine.

Task 2: Turn your head to the right and then to the left, why is it easier for you to do this?

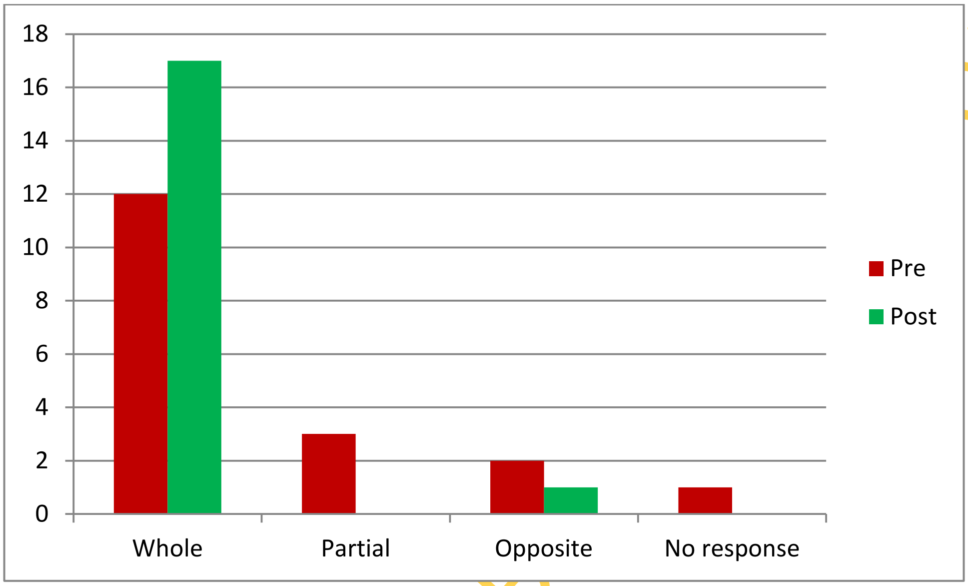

Figure 4.4b: Histogram of Students Pre and Post Intervention Conceptions on Task 2 of Simple Machine

Figure 4.4b reveals that students showed complete understanding of the task as the whole conceptions received a drastic increment in frequency from pre to post intervention. It also indicates that students partial conceptions as well as no response were totally resolved while there was a drop in opposite conceptions.

Task 3: To draw up water from a well, which simple machine will work better?

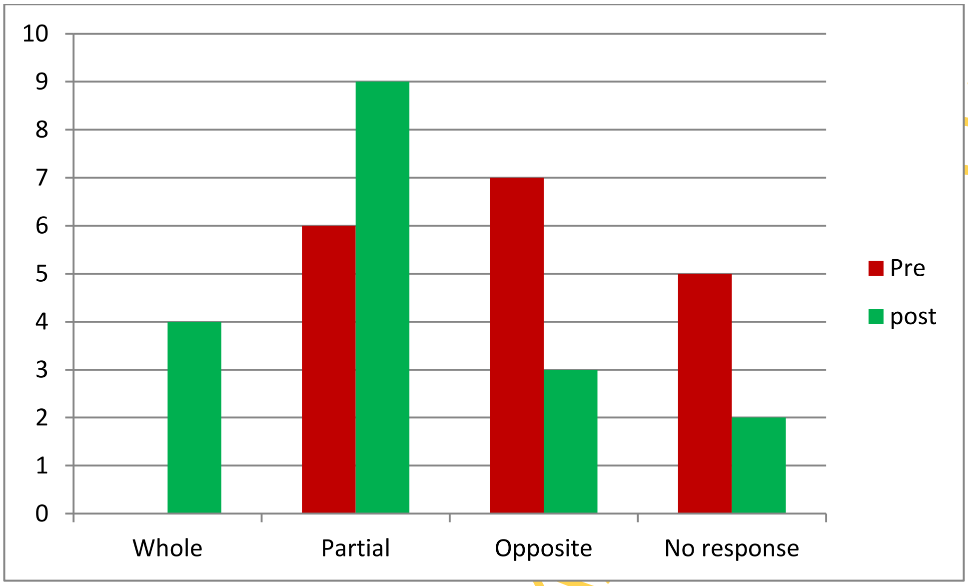

Fig 4.4c: Histogram of Students Pre and Post Intervention Conceptions on Task 3 of Simple Machine

Figure 4.4c shows that students developed from none whole conceptions at pre to 4 post whole conceptions of the third task. While their partial conceptions built up, their opposite conceptions as well as their no response were reduced in magnitude during the post intervention debriefing.

Task 4: A see-saw is an example of which class of lever?

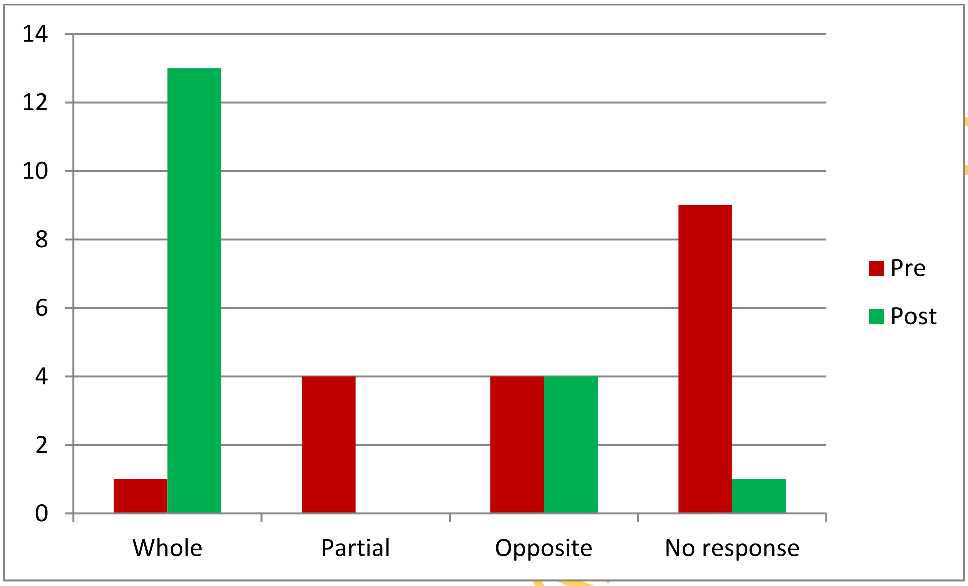

Fig 4.4d: Histogram of Students Pre and Post Intervention Conceptions on Task 4 of Simple Machine

Figure 4.4d indicates that students show significant whole conceptual understanding from pre to post intervention. Students partial conceptions were erased, their opposite conceptions remained unchanged, whereas, their glaring no response at the pre intervention dropped tangibly at the post intervention debriefing.

It is revealed from the preceding graphs that the students post intervention whole conceptions frequencies were higher for all the tasks than the pre intervention debriefings. The graphs also indicated that, though, partial conceptions were built up on some tasks, it called for concomitant reduction of opposite conceptions as well as no response from pre to post intervention. This results imply that the targeted students exhibited better understanding of Basic Science concepts; in other words, there was progressive conceptual growth pattern on the concepts considered in this study.

4.1.2 Which of the instructional strategies would most influence students' retention of Basic Science concepts after four weeks from treatment termination?

Table 4.2 presents the summary of the frequencies of post and delayed post students responses on the Basic Science concepts.

Table 4.2: Frequencies of Responses on Level of Retention exhibited by Students due to Strategy

Group	N	Concept	Whole		Partial		Opposite		No Response	
			Post	Delayed post	post	Delayed post	post	Delayed post	post	Delayed post
Simplex	6	Habitat	9	8	9	8	3	5	3	3
Cognitive Coaching	6		10	8	4	7	3	3	7	6
Control	6		5	2	9	9	6	8	4	5
Simplex	6	Rusting	12	10	5	4	5	6	2	4
Cognitive Coaching	6		13	9	5	6	2	6	4	3
Control	6		10	5	6	5	4	8	4	6
Simplex	6	Energy	13	11	6	2	2	6	3	5
Cognitive Coaching	6		13	10	7	5	3	5	1	4
Control	6		9	6	6	4	5	8	4	6
Simplex	6	Simple Machine	15	13	6	5	2	3	1	3
Cognitive Coaching	6		18	14	3	4	1	2	2	4
Control	6		10	6	4	7	6	6	4	5

Table 4.2, displays the frequencies of 18 selected students responses on the four selected Basic Science concepts at the post and delayed post debriefings. In order to explain the level of retention exhibited by the students, Figures 4.5 to 4.8 were presented to indicate their conceptions: **Whole post**, **Whole delayed post, Partial post, Partial delayed post, Opposite post**, **Opposite delayed post, No response post and No response delayed post**. More emphasis was placed on comparing the post and delayed post whole conceptions of the Basic Science concepts as indicator of students ability to retain what they have learnt.

First concept: Habitat

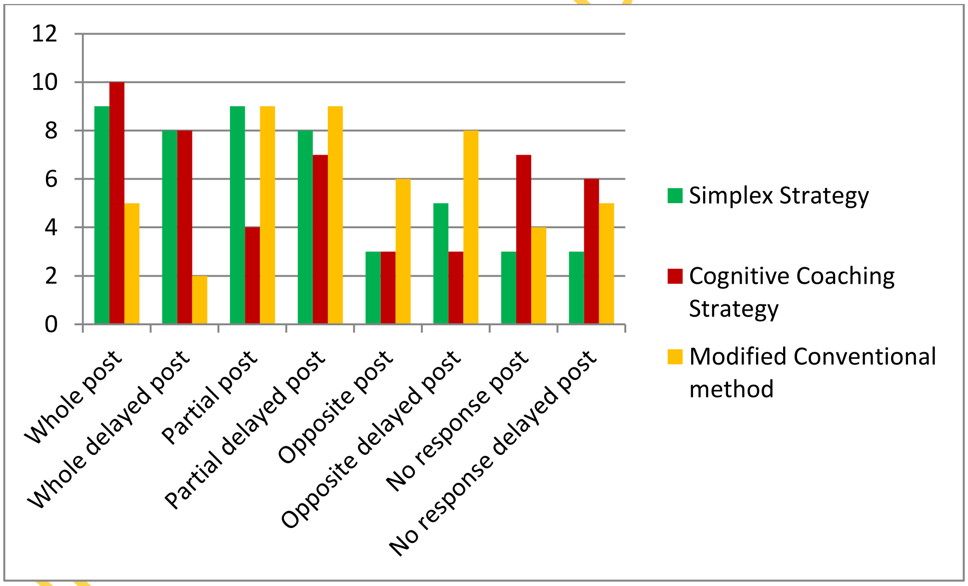

Fig 4.5: Histogram of Students Retention of Tasks on Habitat

It is revealed from Figure 4.5 that students showed different levels of recall and reversion on the tasks on habitat as Basic Science concept. The histogram indicates that the students whole conceptual retention of responses on tasks on habitat dropped slightly as their delayed post debriefing responses frequencies are lesser than the post debriefing responses frequencies in the Simplex strategy (9 to 8); Cognitive coaching (10 to 8) and Modified Conventional method (5 to 2) respectively. Although, their partial conceptions dropped slightly from post to delayed post debriefing in the Simplex strategy (9 to 8), it reverted in the Cognitive coaching (4 to 7) while it remained unchanged in the Modified Conventional method (9 to 9). Students opposite conceptions was reverted from post to delayed post debriefing in the Simplex strategy (3 to 5), it remained unchanged in the Cognitive coaching (3 to 3), while it also reverted in the Modified Conventional method (6 to 8). The graph also reveals that students no response remained unchanged from post to delayed post debriefing in the Simplex strategy (3 to 3), while it dropped slightly in the Cognitive coaching (7 to 6), it reverted slightly in the Modified Conventional method (4 to 5).

Second concept: Rusting

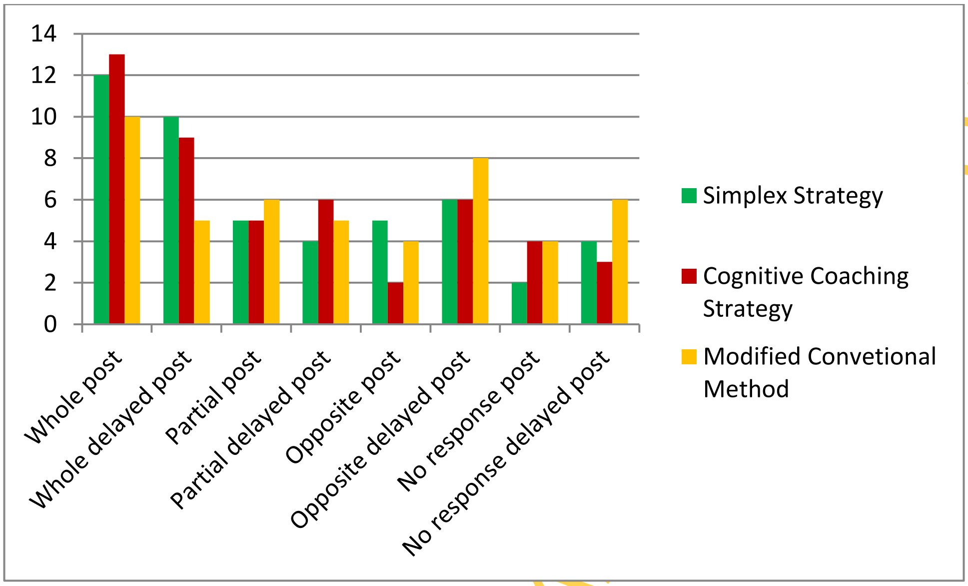

Fig 4.6: Histogram of Students Retention of tasks on Rusting

Figure 4.6 reveals that students showed different levels of recall and reversion on the tasks on rusting as Basic Science concept. Students whole conceptions at post debriefing were higher than those of delayed post debriefing in the Simplex strategy (12 to 10), Cognitive coaching (13 to 9) and Modified Conventional method (10 to 5). This implies that there was a slight drop in students retention of knowledge about the tasks on rusting. It is also indicated by the histogram that though the Simplex group was able to check their partial conceptions at delayed post debriefing slightly (5 to 4), the Cognitive coaching group reverted slightly (5 to 6) while the Control group was also able to check their partial conceptions (6 to 5). Students opposite conceptions increased from post to delayed post debriefing slightly in Simplex group (5 to 6), very much in the Cognitive coaching (2 to 6) and the Control (4 to 8) respectively. It is further shown by the graph that students no response on tasks on rusting increased slightly in the Simplex group (2 to 4), decreased slightly in the Cognitive coaching (4 to 3) while it also increased in the Control (4 to 6).

Third concept: Energy

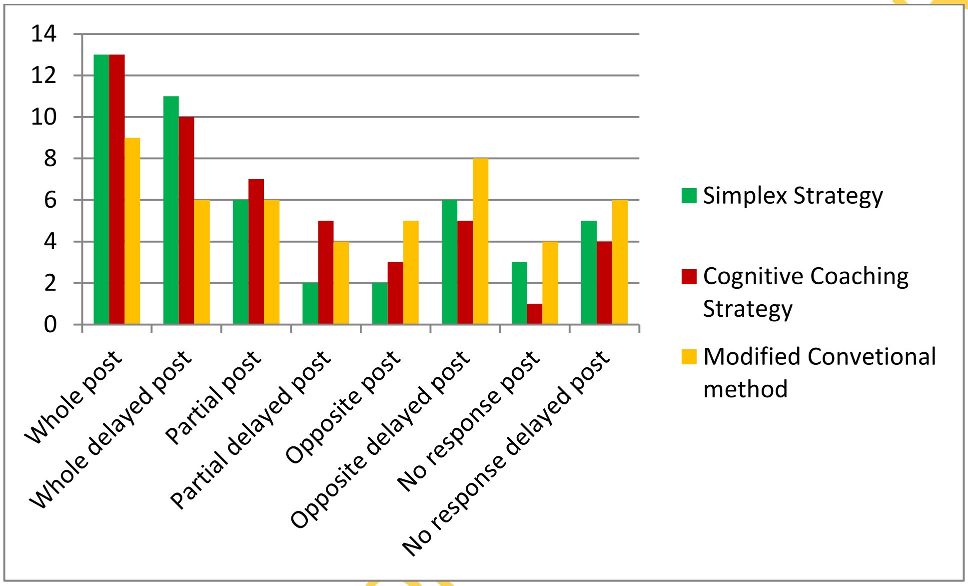

Fig 4.7: Histogram of Students retention of Tasks on Energy

Figure 4.7 indicates that students showed different levels of recall and reversion on the tasks on energy as Basic Science concept. The graph shows that students whole conceptions (retention) of tasks on energy dropped slightly from post to delay post debriefing in the Simplex group (13 to 11) than in the Cognitive coaching (13 to 10) and the Control (9 to 6) respectively. Likewise, the graph indicates that students partial conceptions were checked more in Simplex group (6 to 2) than in Cognitive coaching (7 to 5) and the Control (6 to 4) respectively. The students opposite conceptions as indicated by the graph shows that there were reversions from post to delayed post debriefing in Simplex group (2 to 6), Cognitive coaching (3 to 5) and the Control (5 to 8) respectively. Lastly, students no response also reverted as shown by the bars in the graph in the Simplex group (3 to 5), Cognitive coaching (1 to 4) but dropped slightly in the Control (7 to 6) respectively.

Fourth concept: Simple Machine

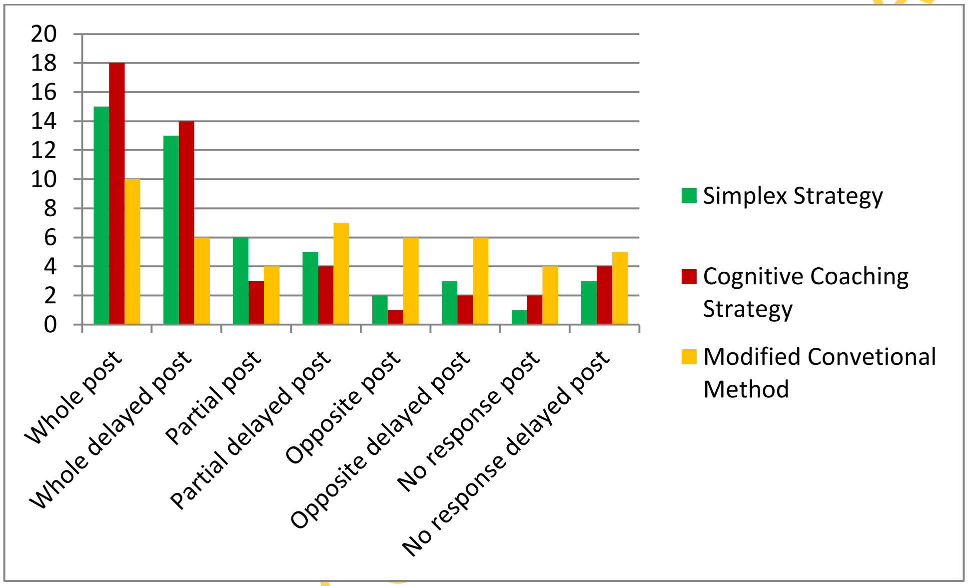

Fig 4.8: Histogram of Students retention of Tasks on Simple Machine

It is revealed from Figure 4.8 that students showed different levels of recall and reversion on the tasks on simple machine as Basic Science concept. The graph indicates that students whole conceptions (retention) of tasks on simple machine dropped almost the same way from post to delay post debriefing in the Simplex group (15 to 13), Cognitive coaching (18 to 14) and the Control (10 to 6) respectively. Whereas students partial conceptions dropped slightly from post to delayed post debriefing in the Simplex group (6 to 5) as indicated on the graph, it reverted a little in the Cognitive coaching (3 to 4) and more in the Control (4 to 7). Similarly, as students opposite conceptions slightly reverted in the Simplex group (2 to 3) and the Cognitive coaching (1 to 2), it remained unchanged in the Control group (6 to 6). Reversion to no response was shown by students on the tasks on simple machine more in the Simplex group (1 to 3) and the Cognitive coaching (2 to 4) than in the Control group with a drop (4 to 5).

These results reveal that the students delayed post debriefing whole conceptions were less than those of the post debriefing in all the groups. This trend shows that there was generally a slight decline in the retention scores in the category of whole conceptions but it is deduced from these results that the drop or decline was more in the Control group (15) followed by the Cognitive coaching group (12) and less in the Simplex group (8). It is also indicated that some students reverted back to no scientific conceptions at the delayed post debriefing. In the category of partial conceptions, reversion was checked with Simplex strategy for all the concepts, followed by the Control with 3 reversions compared to the Cognitive coaching strategy with 5. The reversion trend deduced in the category of opposite conceptions from these results shows that the Cognitive coaching strategy had 7 followed by the Simplex strategy with 8 and 9 in the Control while reversion to no response were 5 each in the Simplex and Cognitive coaching strategies, while 6 was registered in the Control. These results imply that the instructional strategy employed in each group had a significant impact on students capability to retain Basic science concepts. The order being: Simplex > Cognitive coaching > Control.

4.2 Hypotheses: Main Effects

4.2.1.1 H_o 1a: There is no significant main effect of treatment (Simplex strategy, Cognitive Coaching and Modified Conventional Method) on students' achievement in Basic Science.

Table 4.3 presents the summary of analysis of Co-variance (ANCOVA) of students' achievement scores due to treatment, mental ability and self-concept.

Table 4.3: ANCOVA of Posttest Achievement by Treatment, Mental Ability and Self-Concept

Source of Variance	**Hierarchical Method**				
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.(p)**
Covariates PREACHIEVEMENT	207.045	21	207.045	20.521	.000
Main effects (combined)	410.744	5	82.149	8.142	.000
TREATMENT	214.385	2	107.192	10.624	.000*
MENTAL ABILITY	153.369	2	76.685	7.600	.000*
SELF-CONCEPT	42.990	1	42.990	4.261	.040*
2-Way Interactions (combined)	60.843	8	7.605	.754	.644
TREATMENT **X** MENTAL ABILITY	36.324	4	9.081	.900	.465
TREATMENT **X** SELF-CONCEPT	7.698	2	3.849	.382	.683
MENTAL ABILITY **X** SELF-CONCEPT	23.590	2	11.795	1.169	.313
3-Way Interactions TREATMENT **X** MENTAL ABILITY **X** SELF-CONCEPT	76.166	4	19.041	1.887	.114
Model	754.798	18	41.933	4.156	.000
Residual	2058.251	204	10.089		
Total	2813.049	222	12.671		

***Significant at $p < .05$**

From Table 4.3, there was a significant main effect of treatment on students achievement in Basic Science ($F_{(2, 204)} = 10.624$; $P < .05$). There was therefore, a significant difference in the mean achievement scores of students in the Simplex, Cognitive Coaching and Control groups and so hypothesis 1a was rejected.

Table 4.4: Multiple Classification Analysis (MCA) of Achievement According to Treatment, Mental Ability and Self-Concept

Grand mean = 8.56

Treatment + Category	**N**	**Predicted Mean**		**Unadjusted Dev.**	**Eta**	**Adjusted factors and covariates Dev.**	**Beta**
		Unadjusted	**Adjusted for factors and covariates**				
Treatment							
Simplex	78	9.32	9.32	.76		.76	
Cognitive Coaching	58	9.00	8.85	.44		.29	
Control	87	7.57	7.68	-.98	.224	- .88	.205
Mental Ability							
Low	88	7.51	7.88	- 1.04		- .68	
Medium	56	8.01	8.02	- .53		-.54	
High	79	10.10	9.70	1.54	.327	1.14	.239
Self-Concept							
Low	111	8.03	8.11	-.53		-.45	
High	112	9.08	9.00	.52	.148	.44	.126
R = .469 **R squared** = .220							

Table 4.4 shows that students in the Simplex instructional group had the highest adjusted mean score in achievement ($\bar{x}$ = 9.32; adj. dev. = .76) followed by those in Cognitive Coaching ($\bar{x}$ = 8.85; adj. dev. = .29) while the Control group had the lowest mean score ($\bar{x}$ = 7.68; adj. dev. = - .88). This order can be represented as Simplex strategy > Cognitive Coaching > Control.

Further the source of the significant effect of treatment on achievement was traced using Scheffe Post hoc test.

Table 4.5: Scheffe Post hoc Test Achievement by Treatment

Treatment	$\bar{x}$	Treatment		
		1. Simplex strategy	2. Cognitive Coaching	3. Control
1.Simplex strategy	9.32			*
2. Cognitive Coaching	9.00			*
3. Control	7.57	*	*	

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

From Table 4.5, the Simplex instructional group placement in achievement ($\bar{x}$ = 9.32) was significantly different from those of Control group ($\bar{x}$ = 7.57). Similarly, Cognitive coaching instructional group (($\bar{x}$ = 9.00) was significantly different from the Control group. These were the only two pairs which contributed to the significance obtained for treatment on students' achievement in Basic Science.

4.2.1.2 Ho 1b: There is no significant main effect of treatment (Simplex strategy, Cognitive Coaching and Modified Conventional method) on students' attitude towards Basic Science.

Table 4.6 presents the summary of ANCOVA of students' attitude scores due to treatment, mental ability and self-concept.

Table 4.6: ANCOVA of Posttest Attitude by Treatment, Mental Ability and Self-Concept

Source of Variance		Hierarchical Method				
		Sum of Squares	df	Mean Square	F	Sig.(p)
Covariates	ATTITUDE	43.972	1	47.972	.229	.633
Main effects	(combined)	2302.258	5	460.452	2.395	.039
	TREATMENT	1676.693	2	838.347	4.360	.041*
	MENTAL ABILITY	571.220	2	285.610	1.485	.229
	SELF-CONCEPT	54.345	1	54.345	.283	.596
2-Way Interactions	(combined)	2391.892	8	298.987	1.555	.140
	TREATMENT **X** MENTAL ABILITY	1863.307	4	165.827	2.423	.049*
	TREATMENT **X** SELF-CONCEPT	384.234	2	192.117	.999	.370
	MENTAL ABILITY **X** SELF-CONCEPT	29.311	2	14.656	.076	.927
3-Way Interactions	TREATMENT **X** MENTAL ABILITY **X** SELF-CONCEPT	885.010	4	221.252	1.151	.334
	Model	5623.132	18	312.396	1.625	.056
	Residual	39225.181	204	192.280		
	Total	44848.314	222	202.019		

***Significant at p <.05**

The results on Table 4.6 reveal that there was a significant main effect of treatment on students' attitude towards Basic Science ($F_{(2, 204)} = 4.360$; $P < .05$). This result indicates that there was a significant difference in the mean attitude scores of students in the Simplex, Cognitive Coaching and Control groups, thus hypothesis 1b was rejected.

Table 4.7: Multiple Classification Analysis (MCA) of Attitude according to Treatment, Mental Ability and Self-Concept
Grand mean = 49.73

Treatment + Category	N	Predicted Mean		Unadjusted Dev.	Eta	Adjusted factors and covariates Dev.	Beta
		Unadjusted	Adjusted for factors and covariates				
Treatment							
Simplex	78	46.92	46.55	-2.80		-3.18	
Cognitive Coaching	58	48.45	48.69	-1.28		-1.04	
Control	87	53.09	53.28	3.36	.194	3.55	.209
Mental Ability							
Low	88	49.82	48.79	.09		- .94	
Medium	56	47.84	48.16	-1.89		-1.57	
High	79	50.96	51.89	1.24	.085	2.16	.114
Self-Concept							
Low	111	50.77	50.29	1.05		.56	
High	112	48.69	49.18	-1.04	.074	-.55	.039
R = .229 **R squared** = .052							

Table 4.7 reveals that students in Control group had the highest adjusted mean score on attitude towards Basic Science ($\bar{x}$ = 53.28; adj. dev. = 3.55) followed by those in Cognitive Coaching group ($\bar{x}$ = 48.69; adj. dev. = -1.04) while the Simplex group had the lowest mean score ($\bar{x}$ = 46.55; adj. dev. = 3.18). That is, attitude towards Basic Science with respect to strategy is in the order: Control > Cognitive Coaching > Simplex group.

Furthermore, the source of the significant effect of treatment on students' attitude towards Basic Science was traced by Scheffe post hoc test.

Table 4.8: Scheffe Post hoc Test of Attitude by Treatment

Treatment	$\bar{x}$	Treatment		
		1.Simplex strategy	2.Cognitive Coaching	3. Control
1.Simplex strategy	46.92			*
2. Cognitive Coaching	48.45			
3. Control	53.09	*		

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

With respect to Table 4.8, the attitude of students' in the Simplex group ($\bar{x}$ = 46.92) was significantly different from those of the Control group ($\bar{x}$ = 53.09). This was the only pair that contributed to the significance obtained.

4.2.1.3 H_0 1c: There is no significant main effect of treatment (Simplex strategy, Cognitive Coaching and Modified Conventional Method) on students' retention of Basic Science concepts.

Table 4.9 contains the summary of ANCOVA of students' retention of Basic Science concepts scores due to treatment, mental ability and self-concept.

Table 4.9: ANCOVA of Posttest Retention by Treatment, Mental Ability and Self-Concept

Source of Variance	Hierarchical Method				
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.(p)**
Covariates PREACHIEVEMENT	420.678	1	420.678	48.337	.000
Main effects (combined)	724.536	5	144.907	16.650	.000
TREATMENT	567.471	2	283.736	32.602	.000*
MENTAL ABILITY	148.268	2	74.134	8.518	.000*
SELF-CONCEPT	8.797	1	8.797	1.011	.316
2-Way Interactions (combined)	78.294	8	9.787	1.125	.348
TREATMENT **X** MENTAL ABILITY	65.628	4	16.407	1.885	.114
TREATMENT **X** SELF-CONCEPT	.973	2	.487	.056	.946
MENTAL ABILITY **X** SELF-CONCEPT	18.260	2	9.130	1.049	.352
3-Way Interactions TREATMENT **X** MENTAL ABILITY **X** SELF-CONCEPT	33.78	4	8.445	.970	.425
Model	1257.290	18	69.849	8.026	.000
Residual	1775.428	204	8.703		
Total	3032.717	222	13.661		

***Significant at P < .05**

Table 4.9 shows that there was a significant main effect of treatment on students retention of concepts in Basic Science ($F_{(2, 204)}$ = 32.602; P <.05). This means that there was a significant difference in the mean retention scores of students in Simplex, Cognitive Coaching and Control groups respectively, leading to the rejection of hypothesis 1c.

Table 4.10: MCA of Retention Scores by Treatment, Mental Ability and Self- Concept

Grand mean = 6.65

Treatment + Category	**N**	**Predicted Mean**		**Unadjusted Dev.**	**Eta**	**Adjusted factors and covariates Dev.**	**Beta**
		Unadjusted	**Adjusted for factors and covariates**				
Treatment							
Simplex	78	7.71	7.84	1.05		1.19	
Cognitive Coaching	58	7.76	7.67	1.11		1.02	
Control	87	4.97	4.91	-1.68	.365	-1.74	.378
Mental Ability							
Low	88	5.39	5.98	-1.26		- .67	
Medium	56	6.14	6.10	-.51		-.55	
High	79	8.42	7.78	1.77	.364	1.13	.228
Self-Concept							
Low	111	6.28	6.45	-.37		-.20	
High	112	7.02	6.85	.37	.100	.20	.055
R = .615 **R squared** = .378							

Table 4.10 indicates that students in the Simplex group had highest adjusted retention mean score in Basic Science ($\bar{x}$ = 7.84; adj.dev. = 1.19). This group was followed by those in Cognitive Coaching group ($\bar{x}$ = 7.67; adj. dev = 1.02) and the Control group obtained the lowest mean score ($\bar{x}$ = 4.91; adj. dev = -1.74). That is in terms of retention of Basic Science concept based on strategy, Simplex group > Cognitive Coaching > Control.

More also, the source of the significant effect of treatment on students retention of Basic Science concepts was traced with the help of Scheffe post hoc test.

Table 4.11: Scheffe Post hoc Test of Retention by Treatment

Treatment	$\bar{x}$	Treatment		
		1.Simplex strategy	2. Cognitive Coaching	3. Control
1. Simplex strategy	7.71			*
2.Cognitive Coaching	7.76			*
3. Control	4.97	*	*	

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

Table 4.11 shows that Simplex strategy group's retention of Basic Science concepts ($\bar{x}$ = 7.71) was significantly different from those of Control group ($\bar{x}$ = 4.97) and Cognitive Coaching strategy ($\bar{x}$ = 7.76) also differed significantly from their Control group counterpart. These were the only two pairs that contributed to the obtained significance.

4.2.2.1 H_o 2a: There is no significant main effect of mental ability on students' achievement in Basic Science.

From Table 4.3, Mental Ability had a significant effect on students achievement in Basic Science ($F_{(2, 204)}$ = 7.600; P <.05). This implies that students' achievement is significantly different among those of low, medium and high mental ability levels. Hence, hypothesis 2a was rejected.

Similarly, Table 4.4 shows that students with high mental ability had highest adjusted achievement mean score ($\bar{x}$ = 9.70; adj. dev = 1.14) than, those with medium mental ability ($\bar{x}$ = 8.02; adj. dev. = -.5.4) and the low mental ability ($\bar{x}$ = 7.88; adj. dev. = -.68) respectively.

Likewise the Scheffe post hoc test was carried out to determine the source of the significant effect of mental ability on achievement.

Table 4.12: Scheffe Post hoc Test of Achievement by Mental Ability

Mental Ability	$\bar{x}$	Mental Ability		
		1. Low	2. Medium	3. High
1. Low	7.51			*
2. Medium	8.01			*
3. High	10.10	*	*	

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

Table 4.12 shows that the low mental ability students ($\bar{x}$ = 7.51) differed significantly from the high mental ability students ($\bar{x}$ = 10.10) in achievement. Also, the medium mental ability students ($\bar{x}$ = 8.01) differed significantly from their high mental ability counterparts in their achievements. These two pairs therefore contributed to the observed significant effect of mental ability on students' achievement.

4.2.2.2 H_0 2b: There is no significant main effect of mental ability on students' attitude towards Basic Science.

It is observed from Table 4.6 that mental ability had no significant main effect on students attitude towards Basic Science learning ($F_{(2, 204)}$ = 1.485; P >.05). Thus Ho 2b was not rejected.

Also Table 4.7 reveals that students with high mental ability had highest adjusted attitude mean score ($\bar{x}$ = 51.89; adj. dev. = 2.16) followed by those with low mental ability ($\bar{x}$ = 48.79; adj. dev. = -.94) and lastly, those with medium mental ability ($\bar{x}$ = 48.16; adj. dev. = -1.57). However, this difference was not significant.

4.2.2.3 H_0 2c: There is no significant main effect of mental ability on students' retention of Basic Science concepts.

It is revealed from Table 4.9 that mental ability had a significant main effect on students retention of Basic Science concepts ($F_{(2,\ 204)}$ = 8.518; at P <.05). Hence there was a significant difference in the mean retention scores of students in Simplex, Cognitive Coaching and Control groups. As a result, hypothesis 2c was rejected.

Furthermore, table 4.10 shows that students with high mental ability had the highest adjusted retention mean score of Basic Science concepts ($\bar{x}$ = 7.78; adj. dev.= 1.13); those with medium mental ability students were next ($\bar{x}$ = 6.10; adj. dev = -.55) while students with low mental ability had the least posttest mean score ($\bar{x}$ = 5.98; adj. dev = -.67).

To track down the source of the effect of the significance of metal ability on students' retention of Basic Science concepts, the Scheffe post hoc test was conducted.

Table 4.13: Scheffe Post hoc Test of Retention by Mental Ability

Mental Ability	$\bar{x}$	Mental Ability		
		1. low	2. Medium	3. High
1. Low	5.39			*
2. Medium	6.14			*
3. High	8.42	*	*	

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

Table 4.13 shows that the low mental ability students ($\bar{x}$ = 5.39) differed significantly from high mental ability students ($\bar{x}$ = 8.42) and the medium mental ability students ($\bar{x}$ = 6.14) also differed significantly from their high mental ability category. These two pairs therefore contributed to the significant effect of mental ability on students' retention of Basic Science concepts observed.

4.2.3.1 H_o 3a: There is no significant main effect of self-concept on students' achievement in Basic Science.

Table 4.3 Shows that self-concept had a significant main effect on students achievement in Basic Science ($F_{(1, 204)} = 4.261$; $P < .05$). This means that students with high self-concept differed significantly from those with low self-concept. Therefore, hypothesis 3a was rejected.

Table 4.4 also shows that students with high self-concept ($\bar{x} = 9.00$; adj. dev. = .44) obtained higher adjusted achievement mean score than their counterparts with low self-concept ($\bar{x} = 8.11$; adj. dev. = -.45).

4.2.3.2 H_o 3b: There is no significant main effect of self-concept on students' attitude towards Basic Science.

From Table 4.6, it is shown that self-concept had no significant main effect on students attitude towards Basic Science learning ($F_{(1, 204)} = .283$; $P > .05$), Hence hypothesis 3b was not rejected. In addition, Table 4.7 shows that students with low self-concept had higher adjusted attitude mean score ($\bar{x} = 50.2$; adj. dev. = .56) than those with high self concept ($\bar{x} = 49.18$; adj. dev. = -.55). However, this difference was not significant; as a result the hypothesis was retained.

4.2.3.3 H_o 3c: There is no significant main effect of self-concept on students' retention of Basic Science concepts.

Table 4.9 reflects that there was no significant main effect of self-concept on students retention of Basic Science concepts ($F_{(1, 204)} = 1.011$; $P > .05$). So, hypothesis 3c was not rejected. However, table 4.8 reveals that students with high self-concept ($\bar{x} = 6.85$; adj. dev = .20) had higher adjusted retention mean score than those with low self-concept ($\bar{x}$ = 6.45; adj. dev. = -.20). However, this difference was not significant, thus the hypothesis was upheld.

4.3 Interaction Effects

4.3.1.1 H_o 4a: There is no significant interaction effect of treatment and mental ability on students' achievement in Basic Science.

From Table 4.3, it is deduced that the 2-way interaction effect of treatment and mental ability on students achievement was not significant ($F_{(4, 204)}$ = .900; P >.05). Hence, hypothesis 4a was not rejected.

4.3.1.2 H_o 4b: There is no significant interaction effect of treatment and mental ability on students' attitude towards Basic Science.

From Table 4.6, there was a significant 2-way interaction effect of treatment and mental ability on students attitude towards Basic Science ($F_{(4, 204)}$ = 2.423; P <.05). On this basis, hypothesis 4b was rejected. In order to explain the nature of this interaction, Figure 4.9 was presented.

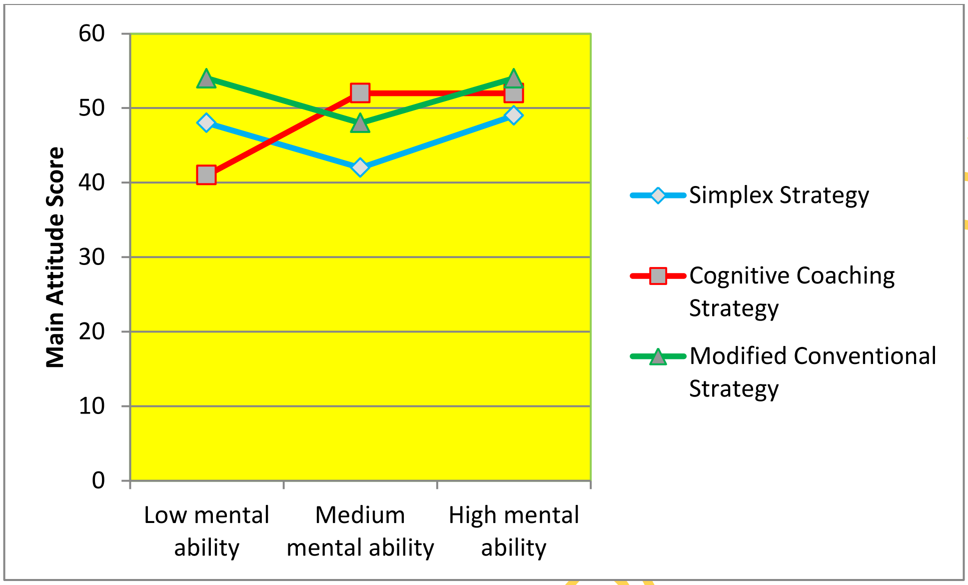

Fig 4.9: 2-Way Interaction of Treatment and Mental Ability on Attitude.

Figure 4.9 shows that among students with low mental ability, the Control group exhibited best attitude than the Simplex and the Cognitive Coaching groups respectively. However, with the medium mental ability group, those in Cognitive Coaching have best attitude than their counterparts in Control and Simplex groups respectively. Further still, the high mental ability students in the Control group exhibited an improvement in attitude most than the Cognitive Coaching and Simplex groups in that order. This interaction was disordinal in nature.

4.3.1.3 H_o 4c: There is no significant interaction effect of treatment and mental ability on students' retention of Basic Science concepts.

With reference to Table 4.9, the 2-way interaction of treatment and mental ability was not significant ($F_{(4, 204)}$ = 1.885; P >.05) on students retention of Basic Science concepts. This necessitated the non-rejection of H_o4c.

4.3.2.1 H_o 5a: There is no significant interaction effect of treatment and self-concept on students' achievement in Basic Science concepts.

Table 4.3 reveals that the 2-way interaction of treatment and self-concept on students' achievement in Basic Science concepts was not significant ($F_{(2, 204)}$ =.382; P >.05) and prompted the non-rejection of hypothesis 5a.

4.3.2.2 H_o 5b: There is no significant interaction effect of treatment and self-concept on students' attitude towards Basic Science learning.

Table 4.6 shows that the 2-way interaction effect of treatment and students self-concept on attitude was not significant ($F_{(2, 204)}$ = .999; P >.05). As a result, hypothesis 5b was not rejected.

4.3.2.3 H_o 5c: There is no significant interaction effect of treatment and self-concept on students' retention of Basic Science concepts.

Based on the result displayed on Table 4.9, it is shown that the 2-way interaction of treatment and students self-concept on retention of Basic Science concepts was not significant ($F_{(2, 204)}$ = .056; P >.05). For this reason, hypothesis 5c was not rejected.

4.3.3.1 H_o 6a: There is no significant interaction effect of mental ability and self-concept on students' achievement in Basic Science.

Table 4.3 shows that the 2-way interaction of mental ability and self-concept on students achievement in Basic Science was not significant ($F_{(2, 204)} = 1.169$; $P > .05$). On this basis, hypothesis 6a was not rejected.

4.3.3.2 H_o 6b: There is no significant interaction effect of mental ability and self-concept on students' attitude towards Basic Science.

Table 4.6 shows that the 2-way interaction effect of mental ability and self-concept on students attitude towards Basic Science was not significant ($F_{(2, 204)} = .076$; $P >.05$). So, hypothesis 6b was not rejected.

4.3.3.3 H_o 6c: There is no significant interaction effect of mental ability and self-concept on students' retention of Basic Science concepts.

Table 4.9 reveals that the 2-way interaction effect of students mental ability and self-concept on retention of Basic Science concepts was not significant ($F_{(2, 204)} = 1.049$; $P > .05$). For this reason, hypothesis 6c was not rejected.

4.3.4.1 H_o 7a: There is no significant interaction effect of treatment, mental ability and self-concept on students' achievement in Basic Science.

From Table 4.3, it is revealed that the 3-way interaction effect of treatment, mental ability and self-concept on students achievement in Basic Science was not significant ($F_{(4, 204)} = 1.887$; $P >.05$). Hence H_o 7a was not rejected.

4.3.4.2 H_o 7b: There is no significant interaction effect of treatment, mental ability and self-concept on students' attitude towards Basic Science learning.

Table 4.6 presents the 3-way interaction effect among treatment, mental ability and self-concept to be insignificant ($F_{(4, 204)} = 1.151$; $P > .05$) on students attitude towards Basic Science. Due to this, hypothesis 7b was not rejected.

4.3.4.3 H_o 7c: There is no significant interaction effect of treatment, mental ability and self-concept on students' retention of Basic Science concepts.

With respect to the result presented on Table 4.9, there was no significant 3-way interaction effect of treatment, mental ability and self-concepts ($F_{(4, 204)} = .970$; $P > .05$) on students retention of Basic Science concepts. Hence hypothesis 7c was not rejected.

Summary of Findings

The major research findings of this study are as summarized below:

1. There was generally progressive growth in students' conceptual understanding of Basic Science concepts as most changed from misconceptions prior to treatment to scientific conception after treatment.
2. Although, there was drop in retention of Basic Science conception, the drop was worst in the Control group than in Simplex and Cognitive coaching groups.
3. There was a significant main effect of conceptual change strategy on students' achievement in, attitude towards and retention of Basic Science concepts. On achievement, Simplex and Cognitive coaching strategies were more effective than the Conventional method. With respect to attitude, the Conventional method was more effective over the experimental groups; while on retention, Simplex and Cognitive Coaching strategies proved effective.

4. There was a significant main effect of students' mental ability on their achievement in and retention of Basic Science concepts. While there was no significant main effect of student mental ability on attitude, students with high mental ability developed best attitude, followed by those with low mental ability, though, not significant from those with medium mental ability.

5. There was a significant main effect of self-concept on students' achievement in Basic Science but not on attitude and retention. For achievement, students with high self-concept performed better than those with low self-concept.

6. There was no significant 2-way interaction effect of treatment and metal ability on students' achievement in, and retention of Basic Science concepts.

7. There was a significant 2-way interaction effect of treatment and mental ability on students' attitude towards Basic Science. To this end the low mental ability as well as high mental ability students showed positive attitudes towards Basic Science in the Control group than in the Simplex and Cognitive Coaching groups respectively. However, the medium mental ability students had favourable attitude towards Basic Science in the Cognitive Coaching group than the Control and Simplex groups respectively.

8. There was no significant 2-way interaction effect of treatment employed and students' self-concept on achievement in, attitude towards and retention of Basic Science concept.

9. There was no significant 2-way interaction effect of students' mental ability and self-concept on achievement in, attitude towards and retention of Basic Science concepts.

10. There was no significant 3-way interaction effect of treatment, mental ability and self-concept on students' achievement in, attitude towards and retention of Basic Science concepts.

CHAPTER FIVE

5.0 DISCUSSION, CONCLUSION AND RECOMMENDATIONS

This chapter deals with the discussion of the results obtained from this study. The educational implications of the findings in this study are equally presented. The conclusion about the study is drawn and recommendations are made.

5.1 Discussion of Findings

The discussion of the findings from this study is done here under on the following sub-titles:

1. Pattern of conceptual change and level of retention
2. The effects of treatment on students
   (a) Achievement in
   (d) Attitude towards and
   (e) Retention of Basic Science concepts
3. The effects of moderator variables on students
   (a) Achievement in
   (b) Attitude towards and
   (c) Retention of Basic Science concepts
4. The interaction effects of treatment and moderator variables on
   (a) Achievement in
   (b) Attitude towards and
   (c) Retention of Basic Science concepts.

5.1.1 Pattern of Conceptual Change in Basic Science Learning

The major finding of this study is that there was generally progressive growth on conceptual understanding of Basic Science concepts of students exposed to Simplex, Cognitive Coaching strategies as well as those in the Control group respectively. This was revealed from the adjustment of learners' prior conceptual framework of the Basic Science concepts considered in this study in a pattern in which there was significant paradigm shift to scientific conceptual verbal expression. It clearly shows that the strategies employed in this study did not only effectively alter learners' conceptual framework of scientific conceptions, it equally helped to remediate misconceptions learners' had prior to interventions. In other words, the strategies afforded the learners the opportunity to exhibit proper understanding and communicate proficiently in the scientific society. This was established from the fact that there was noticeable reduction in partial and opposite conceptual verbal responses as well as no response from pre-treatment to post-treatment stages, while whole conception of scientific concepts built up. The improvement was however more in the experimental groups (Simplex and Cognitive Coaching) than in the Control group. This implies that the conceptual change strategies employed in this study were effective. The pattern showed that the students in the Simplex group improved tremendously from pre to post test conceptual understanding of Basic Science concepts. Those in the Cognitive Coaching group also improved on their conceptual experience about Basic Science concepts significantly. Although, students in the Control group could not show any conceptual change on the first concept (habitat) they however displayed significant improvement also on conceptual understanding of the other Basic Science concepts.

This result was in agreement with the findings of Georghiades (2002) who established that the strategy employed in learning helps a lot in promoting better metacognitive understanding and intentional learning required to produce more desirable conceptual change and retention in science education. And in the case of this study, the Simplex and Cognitive Coaching strategies have been able to prove their worth in the learning of Basic Science. The Cognitive Coaching learning strategy was the most effective followed by the Simplex strategy while the control strategy was the least effective in terms of students' pattern of conceptual change. This is so because the Cognitive Coaching strategy permitted the creation of rapport between the teacher and students, also students had access to reading passages related to the concepts learned and were made to express their views verbally and write down their thoughts. This agrees concomitantly with the proponents of science writing which suggest that writing may support thinking by compelling students to organize their thoughts, lending structure to their arguments and integrating new information with prior knowledge (Keselman et al, 2007), therefore buttressing the view of Hayes (1987). Although, students' academic achievement in Basic Science is determined from a variety of concepts which are spirally arranged in the curriculum, conceptual understanding is only one of the essential ingredients for effective reasoning (Jimenez, Rodrignez and Duschl, 2000) in this strategies argumentation is used to conduct knowledge claims, to evaluate and adjust them on the basis of available evidence and to communicate them to others. Thus, reasoning through counterclaims to coordinate them with students' beliefs resulted in better reasoning and learning outcomes in the classroom.

5.1.2 Level of Retention of Basic Science Concepts

It was found in this study that there was a slight drop (decay) in conceptual retention of the Basic Science concepts considered. This was confirmed from the reduction in the mean scores of the delayed post- treatment verbal responses of the learners compared with those of their post-treatment. The reduction in the mean scores was however more in the Control group than the Cognitive coaching and the Simplex groups respectively. In other words, the learners reverted back slightly from whole conception of scientific concepts to partial conception and opposite conception as well as no response habits in all the groups after an interval of four weeks beyond the termination of the intervention. The reversion was however less in Simplex than in Cognitive coaching and the control groups respectively. That is, the trend of the drop in retention is in the order: Simplex < Cognitive Coaching < Control groups respectively.

The slight drop in retention as registered in this finding corroborated the result of the study reported by Trundle, Atwood and Christopher (2007) who established a gradual partial decay as well as a full decay in retention as time elapsed after end of intervention. The slight decay in retention as obtained in this study could be due to the short interval between post and delayed post retention tests. The reversion from whole conception to partial or opposite conceptions as well as no response could be due to: inconsistency in the use of the strategies which may have weakened their strength; the learners' individual differences emanating from differences in their mental abilities or learning styles and/or inadequate application of the learned concepts.

5.1.3 Effect of Treatment on Achievement in and Retention of Basic Science Concepts

The finding of this study is that there was a significant difference in the students' achievement on Basic Science concepts on exposure to Simplex and Cognitive Coaching strategies as well as the Control method. The Simplex strategy was most effective followed by the Cognitive Coaching strategy while the Control method was the least effective. The Simplex strategy exercised superiority over others (Cognitive Coaching strategy and Modified Conventional method) due to the fact that the learners in the group clearly documented their priorities which allowed them to prepare and present to the class a convincing idea and comprehensive steps to acquire a better scientific understanding of any given Basic Science concept(s). This they did imaginatively by stating facts and ideas, as well as resolved to select the most important insightful facts or solution through judgment and evaluation. They supported all these with follow-up activities. In other words, the students in this group adopted procedural knowledge of metacognitive awareness in their study. Their high degree of procedural knowledge helped them to use skills more automatically (Stanovich, 1990), thus they were more able to sequence their plans effectively (Pressley, Borkowski and Schneider, 1990) and used this procedure qualitatively to solve problems (Glaser and Chi, 1988). As a result, there was improvement in conceptual understanding and achievement. This helped to develop a specifics set of ideas to address some key challenges about their prior knowledge and what work had to be carried out to support learning. It also generated socially very positive feedback and linkages with the students. It enhanced learner's retention of knowledge gained from the activities they actively participated in. This finding corroborated favourably the findings of Basadur (1994) who deduced that Simplex is a complete process of creative conceptual change strategy.

In like manner, Potworowski, et al (2008) also established that Simplex strategy provides opportunities for change and ensures continuous improvement where misconceptions do exist. Simplex method was proposed to solve global numerical optimization problems (Ren, San and Chen, 2007). It has been found to be highly effective on the optimization of high dimensional functions, to direct the orbits of discrete chaotic dynamical systems towards desired target region within a short time by applying only small bounded perturbations (Mili, Tang and Wang, 2004). Melani, Gratteri, Adamo and Bonaccini (2001) also found Simplex strategy very useful for searching the optimal ligand interaction field in drug design. Similarly, from an instructional standpoint, studies have reported that helping younger students increase their procedural knowledge improves their on-line problem-solving performance. King (1991) in his comparative study of fifth-grade students in which individuals solved problems using a problem-solving prompt card and solving problems without it, found that those who received explicit procedural training in the use of the prompt card solved more problems on a paper-and-pencil test and performed better than the other (control) group on a novel computer task. This present study affirms the vital role of procedural knowledge as the students in the Simplex group made use of flash cards in listing the ideas about a concept and selecting the most relevant for an investigation. This habit paid-off as reflected in their outstanding achievement compared with other groups.

Cognitive Coaching strategy was better than the Control because it enabled the learners perform at a higher capacity. The students created rapport, sought precision, refinement and mastery from learning resources and monitor their own values, thought and behaviour as well as their effects. This could have been possible because Cognitive Coaching strategy enables the learners to adopt the conditional knowledge of metacognitive awareness which allowed them to decide when and why to apply various cognitive actions (Garner, 1990; Lorch, Lorch and Kusewitz, 1993). Thus, learners selected different means most appropriate for each situation in an effort to better regulate their learning. This result tends favourably towards the findings of Reynolds (1992) who submits that differences appear among learners to selectively allocate their attention based on conditional task demands. This agrees precisely with the finding of Costa and Garmston (1994) who proposed that Cognitive Coaching supports instructional change while Edwards (2005), Ellison and Hayes (2006) established that it enhances peoples thinking. The importance of conditional knowledge in enhancing learning has been suggested recently to continue to develop at least through middle childhood. Miller (1985) corroborated this suggestion by submitting that although kindergarten pupils showed conditional knowledge about their own learning, they showed less knowledge than older children. This applied comfortably to students in the Cognitive coaching group because they have reached specific developmental stage that enabled them to utilize their conditional knowledge for metacognitive awareness.

Simplex and Cognitive Coaching strategies proved their worth more successfully over the Modified Conventional method because they are both learner-centered conceptual change problem solving approaches that made the learners self-confident in obtaining plausible ideas of the learning processes. This outcome is in line with those presented by Potworowski et al (2008), Costa and Garmston (1994). The purpose of teaching and learning Basic Science as underpinned by the National curriculum programme (NPE, 2004) of study is such that the use of Simplex and Cognitive Coaching strategies help to offer opportunities for learners to develop knowledge and understanding of important scientific ideas, so that they can relate these to everyday experiences. The strategies afforded learners to learn about ways of thinking and of finding out about things and communicating their ideas. They had hands-on experiential aspect of learning, which gave them opportunity to work alongside all other students in a small cooperative manner. The finding in this study also tends toward the results of earlier researchers who had found better achievement with specific noble strategies over the Modified Conventional method. Concept Mapping was reported to bring about improved achievement on ecological concepts over Lecture method (Novak, 1990; Ige, 1998); Inquiry-Discovery was reported to enhance students performance in science over Lecture Method (Beane, 1990; Lang, Katz and Menezes, 1998) etc.

The strategies employed in this study resulted in new experiences and new ways of thinking and experiencing among members of the groups. They created better and broader way for students to experience their environment and help to build their knowledge structures as well as change their erroneous impression about scientific concepts.

5.1.4 Effect of Treatment on Students' Attitude towards Basic Science Learning

The outcome of the analysis of treatment on attitude shows that there was a significant main effect of treatment on students' attitude towards Basic Science. The Control (Modified Conventional) method influenced favourably students' attitude towards Basic Science more than the Simplex and Cognitive

Coaching strategies probably due to the use of charts that may have attracted their attention as well as interest to learn. In all, the Simplex strategy was least favoured or had the least influence on students' attitude in Basic Science. The superiority of Modified Conventional (control) method over Cognitive Coaching and Simplex strategies could be traced to the fact that students are most familiar with the Modified Conventional method, and have adjusted to its use in formulating their way of thinking or of behaving. The Cognitive Coaching and the Simplex strategies may have not significantly affected and influenced students' attitude because the strategies were strange so the students did not effectively subscribe to their innovations or probably the duration of the study was not long enough to have registered any substantial effect. This finding indicated that attitude formed over an interval of time may not be easy to change within a short period. Similarly, students' unfavourable attitude as displayed in the Cognitive Coaching and Simplex strategies may be connected to the limited training which the teachers in these groups have had on the use of the strategies or due to little oversight as well. This finding falls in line with the submission of Aschbacher and Roth (2002) that teacher do not always follow the curriculum guidelines to the letter.

A number of researchers have however linked some notable teaching innovations to positive changes in students' attitudes (Chang and Mao, 1999). Among the studies that reported more favourable attitude of students towards certain discipline due to strategy include: Abimbade (1983), Programmed instruction in Mathematics; Aiyalaagbe (1998), Self-learning strategy; Udousoro (2000), Computer and Text-assisted programmed instruction; Popoola (2002), Self-learning Device and Adesoji (2008), Teacher-directed and Self-directed strategies. These studies suggest that there is a relationship between methods of instruction and attitude. Such attitude linkage to method could be favourable (positive) or unfavourable (negative). This is what the finding in this study reveals.

Many studies reported that inquiry activities resulted in greater interest in science and motivation to do science. Harlen (2004) had reported that inquiry activities do not only lead to more interest in science but that the interest persisted long after the inquiry intervention was over. This assertion ought to have favoured the Cognitive Coaching and Simplex strategies more than the Modified Conventional (control) method in this study but due to oversight and teachers' recipe to justify achievement, little or no concern was given to motivation in the package. This could be because of the resistance on the part of the students to adjust to the dictates or tenets of the reforms or they could have viewed these strategies as intruder to the generally treated norm. It might as well be due to the likelihood of students preferring to work individually or have been used to 'spoon feeding' by their teachers or it could be that they disallow the covering up of their short comings.

However Morel and Lederman (1998) have studied students attitudes towards schools and classroom science and they argued that students attitudes, in general, towards schools are positive, but their attitude towards science are not; there seems to be only a weak relationship between these attitudes indicating that students poor attitudes towards science are not part of a global attitude problem. However, Ogunkola (2002) later found that the attitude of a learner towards science would determine the measure of the learners' attractiveness or repulsiveness to science. This of course connotes that it will invariably influence the learners' choice and even achievement in the subject (Odinko and Adeyemo, 1999).

5.1.5 Effects of Students' Mental Ability on Achievement in, Attitude towards and Retention of Basic Science Concepts

The result obtained in this study reveals that there was a significant main effect of students' mental ability on achievement and retention. Students' achievement and retention in Basic Science differ significantly among those with low, medium and high mental ability categories. Students with high mental ability proved superior to those with medium or low mental ability categories. The achievement of students with low mental ability was also the poorest. This shows that there is a direct correlation between mental ability and achievement as well as retention of Basic Science concepts. However, there was no significant main effect of mental ability on students' attitude towards Basic Science. Yet the students with high mental ability proved superior over others with higher attitudinal mean scores followed by those with low mental ability. The students with medium metal ability had the lowest attitudinal mean scores.

It could be argued here that though mental ability is an important factor for students achievement and retention of Basic Science concepts, it did not affect or contribute to students way of behaving in the Simplex group .This finding revealed the fact that the high mental ability students have been subjected to similar instruction which has proved to be interesting and could adjust favourably to any innovations over a period while those with low mental ability could as a matter of fact, be the recipient of extra help that necessitated improved changed attitude in the control group. The students with medium mental ability may have refused to give in to the learning situation or remained unaltered by the learning activities due to weaknesses in absorption of cultural change. This view gave support to the assertion that a very general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience is not merely book learning, a narrow academic skill, or test taking smarts (Wikipedia, 2010). Rather it reflects a broader and deeper capability for comprehending our surroundings -"catching on", "making sense" of things or "figuring out" what to do. This finding implies that though students' level of abilities is one of the major predictors of school success (Sternberg, 1986; Carroll, 1991), yet abilities do not predict school performance completely. The difference observed between students with medium mental ability and others shows that individuals differ from another in their ability to understanding complex ideas, to adapt effectively to the environment, to learn from experience, to engage in various forms of reasoning and to overcome obstacles by taking thought. It thus implies that educators consider individual differences in underscoring the variable that may be responsible for learning outcomes in Basic Science.

5.1.6 Effect of Students' Self-Concept on Achievement in, Attitude towards and Retention of Basic Science Concepts

The finding in this study shows that there was a significant main effect of students' self-concept on achievement but with no significant main effect on students' attitude and retention. Students with high self-concept had higher achievement mean score than their counterparts with low self-concept. The significant effect of students' self-concept on achievement as found in this study could be linked to students' declarative knowledge of metacognitive awareness. This enabled the students to have the knowledge about themselves individually and about what factors influence one's performance. This agrees favourably with the findings of Garner (1987) and Schneider and Pressley (1989) who found that good learners appear to have more knowledge about their own memory and are more likely than poor learners to use what they do know. Results of studies conducted by earlier researchers also revealed that there is a mutual causality between the academic self-concept and the academic achievement of students (Honsford and Hattie, 1982; Guay, Marsh, and Boivin, 2003). The students with high self-concept could have benefited considerably in academic achievement due to the fact that they tended to invest more time to engage in learning activities. On the other extreme, students with low self-concept may have shown passive investment to learning thereby resulting in weaker achievement. From all indications therefore, it could be argued that students who perceive themselves to be more effective, more confident and more able, accomplish more than students with less positive self-perceptions. This implies that academic self-concept has motivational properties such that changes in academic self-concept will lead to changes in subsequent academic achievement and vice versa. Furthermore, Marsh (2003) maintains that as children grow older, their academic self-concept responses became more reliable. This reliability on self-concept responses is of course a fuel necessary to keep the engine of academic achievement running efficiently. This corroborated the findings of Akinsola (1994), Vispeol (1995), Erekosima (1996) and Ifemuyiwa (1998) who obtained a mutual relationship between students' performance and self-concept.

Though there was no significant effect of self-concept on students' attitude, yet students with low self-concept had higher adjusted attitude mean score than students with high self-concept. This means that perception of self may not necessarily dictate one's attitude. The implication of this is that it may not be right to judge students attitude with self-concept. Similarly, there was no significant effect of students' self-concept on retention; it nonetheless did not indicate a discrepant division between high and low levels of self-concept. The result showed that students with high self-concept had higher retention capability than their low self-concept category. This follows similar pattern as observed in the relationship between self-concept and achievement. As a result, maintaining high self-concept therefore can enhance retention of what has been achieved relative to low self-perception. This deduction did not deviate from the results obtained by Salami (1987) and Busari (1997) in their separate studies in which low self-concept was identified to be responsible for poor academic achievement in science subjects.

5.1.7 Two-Way Interaction Effect of Treatment and Mental Ability on Students' Achievement in, Attitude towards and Retention of Basic Science Concepts

The result obtained in this study on the two-way interaction effect of strategies employed and students mental ability on achievement and retention showed that, the interaction was not significant in students Basic Science achievement and retention but was significant on attitude. The students with low mental ability and those with high mental ability displayed positive attitude towards Basic Science in the Control group. The reason for this could be that the students in these categories have become accustomed to the method while those in the Simplex and Cognitive Coaching groups may have encounter the conditional package in their groups to be too demanding as opposed to the preferred usual routine which gives room for passiveness or because they were used to individualised work and would not want their weaknesses to be exposed in the sub-groups formulated in the experimental strategies.

The finding of this study however, is that Cognitive Coaching strategy is best for students with medium mental ability. The students with medium mental ability in the Cognitive Coaching group pop-up a positive attitude towards Basic Science better than in the Control and Simplex groups. This could be due to the self-consistency modes of functioning, which individual student in various sub-groups in Cognitive Coaching strategy exhibited in their perception and intellectual activities embarked upon in the classroom. Myers (2003) have distinguished between two attitudes as extroversion and introversion. The preferred styles of work (i.e, creation of rapports in the Cognitive coaching group) in the classroom may have boosted an extroversion type of attitude of the students with medium mental ability in the group. This finding subsumes that social and practical elements of learning converge (Vygotsky, 1996) due to the strategy for students with medium mental ability. This implies that Cognitive Coaching strategy was more interesting to students with medium mental ability. Although, the students with medium mental ability in the Simplex group received instructional package as well, their attitude toward Basic Science was not favourable like it was for those in the control group. The students with medium mental ability in the control and the Simplex groups may fall in the category of introversion type of attitude since the interaction among the students, teachers and instructional strategies did not create forum for 'jokes' or rapport as exhibited in the Cognitive coaching group.

5.1.8 Two-Way Interaction Effect of Treatment and Self-Concept on Students' Achievement in, Attitude towards and Retention of Basic Science Concepts

It was found in this study that the interaction effect of treatment and self-concept was not significant on achievement, attitude towards and retention of Basic Science concepts. This connotes that the strategy employed has no impact on one's perception of self with respect to contributing meaningfully to achievement, attitude or retention. Perceiving self as high or low object does not matter or determine one's capability to display academic learning outcomes.

5.1.9 Two-Way Interaction Effect of Mental Ability and Self-Concept on Students' Achievement in, Attitude towards and Retention of Basic Science Concepts

The finding in this study is that the two way interaction effect of mental ability and self-concept on achievement in, attitude towards and retention of Basic Science concepts is not significant. This reveals that irrespective of students' mental ability (low, medium or high), perception of self has no impact with respect to mental ability on quality achievement, favourable attitude and better retention of Basic Science concepts. This result is a signal calling the attention of stakeholders in educational system to take precautions on considering factors that can jointly influence students learning outcomes.

5.1.10 Three-Way Interaction Effect of Treatment, Mental Ability and Self-Concept on Students' Achievement in, Attitude towards and Retention of Basic Science Concepts

The result obtained in this study indicates no significant interaction effect of treatment, mental ability and self-concept on achievement in, attitude towards and retention of Basic Science concepts. This means that irrespective of the strategy, the level of mental ability as well as the perception of self, students' achievement in, attitude towards and retention of Basic Science concepts could not be determined by the variables considered in this study when jointly reacting. It is thus pertinent for educational practitioners to accommodate contributory factors to achievement in, attitude towards and retention of Basic Science concepts singly in order to boost which ones can bring about fruitful result.

5.2 Conclusion

This study was conducted due to concerns of educators on the persistent teacher dominated instructional strategies employed in schools which have been responsible for students poor achievement in Basic Science.. Modern trends in research and literature support the active involvement of learners in the learning process while de-emphasizing the role of the teacher (Smith, Carey and Wiser, 1985; Pines and West, 1986; Von Glasersfeld, 1993; Davis, 2001). This study revealed that Simplex and Cognitive Coaching strategies are suitable for conceptual change as well as at improving students' achievement in Basic Science classroom activities. This has been reflected due to the fact that both Simplex and Cognitive Coaching strategies empowered learners to dispel resistant erroneous entry conceptions by actively investigating phenomena through hands-on activities and are convinced with results obtained. This culminated in self-confidence with respect to their abilities and self-efforts. Students were able to reflect on their entry experiences and consequently took action on the appropriate channels to follow to the achieved success in Basic Science learning. The strategies allowed students to focus on how individuals within a group can process information across many content areas by making students to be active, engaged in exploring, experimenting, creating, applying and evaluating, as well as interacting actively with the content and concepts they were studying. These strategies emphasized thought as a vital component of learning. Although, students' self-concepts could not show-case any influence vis-a-viz the strategies used on students achievement, students with medium mental ability were favoured in attitude with Cognitive Coaching strategy. This study has therefore confirmed that the use of these strategies (Simplex and Cognitive Coaching) can improve students learning outcomes in Basic Science if there is consistency in their use.

5.3 Educational Implications of the Study

The lowered standard in academic achievement of students is of great concern in this modern technology era. The need to therefore entrench students' attitude towards Basic Science and promote their learning outcomes cannot be an overstatement in classroom interactions. This research has focused on how conceptual change strategies could be appropriate in this direction. The implications of the findings are as discussed hereunder:

(i) Choice of Strategies

The poor academic achievement of students in Basic Science in Modified Conventional (control) method reveals that Basic Science learning must hinge on increasing learners active involvement in the learning process rather than teacher dominated role. Thus only creative strategies that can assist learners to be in-charge of their learning processes must be favoured in Basic Science. The teacher's roles need a paradigm shift from an authority to a facilitator who stimulates learners' active participation in the learning processes by equipping them with all the rudiments of conceptual change strategies which will enable students to develop more effective and plausible scientific conceptions.

(ii) Attitudinal Change due to Strategies

The implementation of the Simplex and Cognitive Coaching strategies may be problematic in the classroom and could have erred either on the side of too much or two little guidance. The structured activities in Simplex and Cognitive Coaching strategies have only taught students to simply 'follow the recipe' with a focus on more expectations but little or no interest or motivation. It is supposed that students' attitudes about Basic Science may play an important role in future success and persistence in science related enterprises. As a result, implementation of the pedagogies requires in depth training and a time lag to guarantee their impact on students attitude towards Basic Science.

(iii) Relevance of Students Variables in Learning

The result of causal modeling studies in learning provide clear affirmative answer to such puzzle as: "do changes in students variables lead to changes in learning outcomes"? This study has revealed conflicting influence of students' variables to learning. As noted, mental ability led to increased achievement and retention but not influence on attitude. This indicates that there existed individual differences among the learners ability to understand concepts and adapt to specific stimulus. As a result, teachers need to enhance students' variables alongside as to sustain achievement over long lasting period.

Also, self-concept led to subsequent academic achievement but not attitude and retention. Hence, not only is self-concept an important outcome variable in itself but that it plays a central role in mediating the success in academic achievement. When the direction of causality is from self-concept to academic achievement (self-enhancement model) as revealed in this study, the teacher might be justified in placing more effort into enhancing students' self-concept rather than fostering achievement.

5.4 Recommendations

The following are desirable recommendations made in the light of the findings of this study:

(1). The use of Simplex and Cognitive Coaching strategies are recommended for learning Basic Science in Junior secondary school level since they are responsible for bringing about quality achievement and retention as well as influencing students favourable attitude towards the subject.

(2). The use of Cognitive Coaching is recommended for medium mental ability students as this favoured attitudinal disposition towards Basic Science.

(3). Students mental ability should be boosted by teachers by exposing them to a variety of experiences because this helped to improve achievement and retention.

(4). Teachers should enhance students' self-concept and achievement alongside each other, as this helped to sustain achievement over a long lasting period.

(5). Curriculum planners should consider Simplex and Cognitive Coaching strategies as indispensable tools for teachers, in view of their contribution to learning outcomes as a result, there is the need for seminars or workshops where teachers could be trained on their adoption.

(6). Teachers should consider specific variables like mental ability and self-concept as determinants of students learning outcomes since students achievement has been discovered to be a product of multiple of factors.

(7). Active participation of students in learning Basic Science is necessary, as this has helped students to identify and understand scientific processes.

(8). Social interaction in small groups among students should be encouraged in schools, since this has paved way for cross linkage of ideas.

(9). Students should be encouraged by the teachers to read and express their feelings, because this has helped students to communicate their thoughts in simple correct language of discussion.

(10). The family, as a microcosm of the larger society, should encourage a free socially interacting environment in order to help enhance high self-concept in students.

(11). Students should be encouraged to be flexible in their believes, interests and values, because this has helped to foster favourable attitudinal disposition towards learning in the experimental groups.

(12). Teachers should support students from behind and not command ahead in view of the fact that this was a means for instilling self-confidence in the students.

(13). Individual differences of the students should not be underrated by the teachers, this being so because their feelings may make or mar the success of the learning processes.

(14). The government, as a matter of consolidating its investment on education, should not relent in its effort at supplying instructional resources (both consumable and non-consumable) to schools since this will in no small measure contribute to sources through which knowledge is gained and built.

(15). Teachers should expose students to examining and handling of instructional materials for various practical activities, this being necessary because it enabled students to become active participants and dispelled erroneous beliefs.

(16). Practicing teachers should always create revision period before examination of at least a week with the students purposely to help rejuvenate decaying memory.

5.51 Contributions to Knowledge

In the light of the findings of this study it has contributed to the enhancement of learning outcomes in Basic Science in the following ways:

(i). It has revealed that conceptual change strategies are effective at improving students learning outcomes in Basic Science by helping to remedy misconceptions and shifting students from faulty perception to acceptable scientific conceptions.

(ii). It also shows that specific strategy (Simplex and Cognitive coaching) can cross link with other variables (mental ability) to bring about improvement in attitude towards Basic Science.

(iii). The results affirm that the strategies are effective for retention of scientific concepts.

(iv). The result of the findings fuels further research need that can elicit positive attitude of the learners based on the use of conceptual change strategies with specific moderator variables.

(v). The findings serve as feedback to curriculum planners on their recommendations on learning strategies rather than teaching strategies.

(vi). The results also serve as feedback to parents and all stakeholders on learners progress.

(vii). The findings also serve as feedback to government to ensure regular sponsorship of seminars, workshops or in-service training of teachers to be kept abreast of innovations as we now-to-for swim in the ocean of modern technology.

5.5.2 Limitations of the Study

It is acknowledged that there are certain limitations which may prevent the generalization of the results of this study as indicated below.

-The time frame of the research may be considered short for convincing and reliable results to be established.

-The study was carried out in six junior secondary schools in three local government areas (Moro, Ifelodun and Kaiama) of Kwara State; there is therefore the need to replicate this study to involve larger sample and other states of the federation.

-The use of the strategies proposed in this study appears relatively new in the field of Basic Science education in Nigeria, as a result most of the literature and references cited in connection to Simplex and Cognitive Coaching strategies are foreign.

-The study was conducted on only four selected concepts from Junior secondary school Basic Science curriculum, as a result, the study could be extended to some other concepts.

-It was not possible for the research to randomly assign the participants to the treatment and control because intact classes were used in order not to disrupt school schedule, it therefore requires that the generalization drawn from this study be considered with avoidance of rashness.

-More also, only mental ability and self-concept were moderator variables considered among others, the generalization of the findings in this study could be established with other moderator variables like: gender, socio-economic factors, school environment, verbal ability, language of science, etc.

The perceived limitations notwithstanding, it is the feelings of expectation and desire of the researcher that the findings of this study would serve as basic underlying principles for future studies in the area of conceptual change learning strategies and their utilization for effective teaching-learning of Basic Science in Junior secondary schools.

5.5.3 Suggestions for further Studies

The results of this study had pop-up some pertinent pit-falls. Thus it is suggested that the following areas be further investigated:

-The efficacy of Simplex and Cognitive Coaching strategies on other concepts,

-The relative effect of Simplex and Cognitive Coaching strategies on attitude to be replicated,

-The mixed result of mental ability and strategy on attitude to be investigated,

-Investigation of other moderator variables (gender, social-economic factors, etc) alongside the strategies investigated herein.

REFERENCES

Abimbade, A 1993. The relative effectiveness of programmed instruction to the Traditional teaching of secondary mathematics. Unpublished M. Ed Dissertation, University of Ibadan.

Abimbola, J. O. 1977. African Word view and Science. *Journal of Science Teachers Association of Nigeria*. 16.1:15-28.

Adam, S. 2004. Using learning outcomes, report for United Kingdom, Bologua Seminal 1-2 July 2004, Heriot-Watt University. Edinburgh Conference center, Edinburgh Scotland.

Adesoji, F. A. 1999. Knowledge of Integrated Science of pre-requisite capacity for first year senior secondary school sciences and implication for teacher education. Abimbade A. Ed. Teacher and Teacher preparation in the Twenty first century. *Development of Teacher Education*. 77-81.

Adesoji, F. A. 2008. Managing students attitude towards science through problem-solving instructional strategy. Anthropologist. 10.1: 21 – 24.

Adeyegbe, S. A. 2005. In search of indices for measuring the standard of education: A need for a shift in paradigm. Paper presented at a special seminar for West African Examinations Council, Lagos 2nd March.

Adeyemi, M. A. 1987. Effects of cognitive style and two instructional modes on students' achievement in Biology. Ph D. Thesis. Dept of Teacher Education. University of Ibadan. x + 72pp.

Afuwape, M. O. 2004. Enhancing creativity in Integrated Science. *International Journal of Emotional Psychology and Sport Ethics* 6, 45-51.

Agusiebo, B. C. 1997. The level of use of low resources in Integrated science master plan by the teacher: Challenges and prospects. Educational challenges in Africa for the 21st century. *A Book of Reading for the*

World Council for Curriculum and Instruction Akoka-Lagos. Jos publishers. 111-122.

Aiyelaagbe, G.O. 1998. *The Effectiveness Of Audio, Visual and Audio-Visual Self-Learning Packages in Adult Learning Outcomes in Basic Literacy Skills in Ibadan.* Unpublished Ph.D Thesis, University of Ibadan.

Ajiboye, J. O. 1996. A self-learning programme. The Modified lecture method and students' cognitive and affective outcomes in some population education concepts. Ph.D. Thesis. Department of Teacher Education. University of Ibadan. iv+56pp.

Akindehin, F. 1988. Effect of an Instructional Package on Pre-service Science Teachers Understanding of the Nature of Science and Acquisition of Science-related Attitudes. *Science Education* 72: 73-82.

Akinsola, M. K. 1994. Comparative effects of mastery learning strategies on students achievements and self-concept in mathematics. Unpublished Ph.D Thesis, University of Ibadan, x + 243pp.

Akpan, E. U. U. 1987. Winning more Students for the Sciences: The factors of Attitudes, Sex, Intelligence, Personality and type of School. *Proceedings of the 28th Annual conference of Science Teachers Association of Nigeria.* Mushin Nigeria: Akin Bolutife printers.

Aladejana, F. 2007. The implication of ICT and NKS for science teaching: Whither Nigeria. *Complex systems*. 17. 113-124.
American Political Science Association. 117-37. Sun & Light, 15.

American Association for the Advancement of Science/project 2061. 1993. Benchmarks for science literacy American Association for the Advancement of Science New York: Oxford University press. *American Political Science Association*, 117-39. Sum & Light, 15.

Anderson, L. W. 1981. Assessing affective characteristics in the schools. Allyn and Bacon, Boston Massachusetts.

Anderson, l. M., Ryan, D. W. and Shapiro, B. J. 1989. Eds. The IEA classroom environment study. Pergamon Press, Oxford.

Anyanechi, M. E. C. 2008. Teaching science in Nigerian secondary schools using a constructivist model. *Educational Research and Review*. 3:7. 242-245. http.//www.academicjournals.org/ERR.

Aremu, O. D. 1997. Effects of two Group Counseling Approaches on Self-concept, Locus of control and Attitude of Selected Adolescents Towards Science. PhD. Thesis. Dept of Guidance and Counseling. University of Ilorin.

Asan, A. 2007. Concept mapping in science class: A case study of fifth grade students'. *Educational Technology and Society*. 10:1. 186-195.

Aschbacher, P. R. and Roth, E. J. 2002. What's happening in the elementary inquiry science classroom and why? Examining patterns of practice and district factors affecting science reforms. Policy levers for urban systemic mathematics and science reform: impact studies from four sites. Paper presented at AERA, 2002, New Orleans, LA.

Asonibare, J. B. 1984. The Nigerian Science Teachers and Stress Management. *Journal of Science Teachers Association of Nigeria.* 22.2:14-19.

Ato, T. 1986. Factors Related to Students Attitude Toward the Difficult/Easiness of Science in Benue State. *Proceedings of the 22nd Annual conference of Science Teachers Association of Nigeria* Mushin, Nigeria Akin Bolutife printers.

Ausubel, D. P. 1968. *Educational Psychology*: A cognitive view New York: Holt, Rinehart and Winston Inc.

Awokoya, S. O. 1976. Science and National Development. *Journal of Science Teacher Association of Nigeria.* 14.3:19-26.

Aworanti, O. A. 1991. Students perception of Integrated science teaching in Nigeria. http://www.unilorin.edu.ng/unilorin/journals/education/ije/dec1991/STUDENTS%20PERCEPTION%200F%20INTEGRAED%20SCIENCE%20TEACHING%20IN%20NIGERIA.pdf. Retrieved date: 2nd October, 2009.

Azeke, T. O. 1997. Discrepancies between curriculum goals and objectives and learning outcomes in secondary school science courses: Challenges for Nigeria and other African countries. *A Book of Reading for the World Council for Curriculum and Instructions*. Akoka-Lagos. Jas publishers. 55-66.

Bagozzi, R. P. and Burnkrant, R.E. 1979. Attitude organization and the attitude-behaviour relationship. *Journal of personnel Social Psychology*.37.6: 913-29.

Bajah, S. T. 1982. Two Decades of Primary Science in Nigeria: *A critical evaluation. A paper presented at the 23rd Annual conference of STAN* 22nd-28th August.

Bajah, S. T. 1995. The challenges of sciences technology and teacher education in Nigeria beyond the year 2000. *African Journal of Education.* 9.1:43-49.

Bakare, C. G. M. 1975. Some Psychological Correlates of Academic Success and Failures. *African Journals of Education Research.* 2.1:11-22.

Ballenger, C. 1997. Social identities, moral narratives, scientific argumentations: Science talk in a bilingual classroom. *Language and Education* 11:1-14.

Ballenger, C. 2000. Bilingual in two senses. Beykont, Z. Ed. Lifting every voice: *Pedagogy and the Politics of Bilingualism* 95-112. Cambridge. MA: Harvard Education publishing.

Balogun, T. A. and Odubunmi, E. O. 1980. The attitude of some Nigeria students towards Integrated Science. *Journal of Research in Curriculum* 1.

Bamidele, A. F. 2000. Experimental Designs in Psychology and Education. Ideal Press Lagos.

Bandura, A. 1977. Social Learning Theory Englewood Cliffs, New Jersey: Prentice-Hall 1.

Basadur, M. 1994. Simplex method. Retrieved from File://localhost/F:/Simplex%20%20A%20powerful%20problem%20solving%20p. on 05/01/2008 02:27:06 pm.

Beane, J. A. 1990. Affect in the curriculum: Towards democracy, dignity and diversity. New York: Teachers College Press.

Bello, O. O. 1995. Effects of problem-solving instructional strategies on students learning outcomes in Chemistry. Ph D. Thesis. Dept of Teacher Education. University of Ibadan.

Berieter, C. 1985. Towards a Solution of the Learning Paradox. *Review of Educational Research* 13:233-341.

Berluti, A. 1992. Science 6-14. An activity and resource manual for teachers. MacMillan Kenta.

Biagioli, M. Ed. 1999. The science study reader. New York: Routledge.

Bloom, B. 1977. Affective Outcome of School Learning. Pludetta Kappan 59:193-198.

Blosser, P. E. 1981. Critical Review of the role of the Laboratory in science teaching. ERIC clearinghouse for science, mathematics and environmental education. Columbus Ohio. ED 206445.

Boguta, K. 2004. "Complexity and the paradigm of Wolfram's *A New Kind of Science Complexity*. 10:4. 15-21.

Boyce, B. A. 1992. The effects of three styles of teaching on University students' motor performance. *Journal of Teaching in physical Education*. 11:4. 389-401.

Brookover, W. B., Shailer, T. and Patterson, A. 1964. Self-concept of Ability and School Achievement. *Sociology of Education* 37:271-278.

Brooker, G. 2000. *The Maths Game.* The National Centre for Vocational Education Research, Wellington.

Brouwer, W. 1984. Problem-solving Physics: A conceptual approach. *American Journal of Physics*. 52. 602 – 607.

Bruner, J. S. 1964. The Process of Education. Cambridge, mass: Harvard University press, 1960. Robert, M. Gagne, The conditions of learning New York: Holt, Rinehart and Winston, 1977; and Jean Piaget, "cognitive development in children: Development and learning:. *Journal of Research in Science Teaching.* 2: 176 – 186.

Bruner, J. 1995. The Culture of Education. Cambridge, MA: Harvard University Press.

Burn, R. B. 1977. The Self-concept and its Relevant to Academic Achievement. London: Holt Rinehart and Winston.

Busari, O. O. 1991. Sustaining Student's Interest in Science. Influence of Cognitive and Teacher Variables. *Journal of Science Teachers Association of Nigeria* 27:1.7-13.

Caramazza, A., McCloskey, M. and Green, B. 1981. Naïve Beliefs in "Sophisticated" Subjects: *Misconceptions about Trajectories of Objects Cognition* 9:117-123.

Cardak, O., Onder, K. and Dikmenli, M. 2007. Effect of the usage of laboratory method in primary school education for the achievement of the students' learning. *Asia-Pacific Forum on Science Learning and Teaching, Volume 8, Issue 2, Article 3* (Dec., 2007) HKIEd APFSLT.

Carey, S. 1985. Conceptual Change in Childhood. Cambridge, MA: MIT Press.

Camagey, N. L. and Aderson, C. A. 2005. The effects of reward and punishment in violent video games on aggressive affect, cognition and behavior. *Psychological Science.* 16. 882 – 889.

Carol, E. J. R. 2001. A comparative study of achievement in college-level written business communication using lecture and cooperative learning teaching methods. Doctoral dissertation, Oklahoma State University, 1989. Dissertation Abstracts International, 50/12, 3832A.

Cattell, R. B. 1971. Abilities: Their Structure, Growth and Action. Hoighton Mifflin. Boston, Massechusetts.

Champagne, A. B., Gunstone, R. F. and Klopfer, L. E. 1985. Consequences of Knowledge About Physical Phenomena. In West, L. H. T. and Pines, A. L. Eds. *Cognitive Structure and Conceptual Change*. New York, Academic Press.

Chang, C. Y. and Mao, S. L. 1999. The effects on students cognitive achievement when using the cooperative learning method in earth science classrooms: *School Science and Mathematics*. 99.

Chen, G., Whiteman, J., Gully, S. M. and Kilcullen, R. N. 2000. Examination of relationships among trait-like individual differences, state-like individual differences, and learning performance. J*ournal of Applied Psychology*, 85. 835 – 847.

Cheung, K.C. and Taylor, R. 1991. Towards a humanistic constructivist model of science learning: *Changing perspectives and research implications. Journal Curriculum. Stud.* 23.1: 21-40.

Chi, M. 1992. Conceptual Change within and across Ontological Categories: *Examples from Learning and Discovery in Science Minnesota studies in Philosophy of Science* 15:129-182.

Chi, M. T. H. and Roscoe, R. D. 2002. The processes and challenges of conceptual change. In Limon, M. and Masin, L. Eds. Reconsidering conceptual change: *Issues in Theory and Practice*. Dordrecht. The Netherlands: khiwer Academic Publishers.

Chi, M. T. H., Slotta, J.D. and deLeeuw, N. 1994. From things to Processes: A theory of Conceptual Change for Learning. *Science Concepts Learning and Instruction* 4: 27-43.

Chi, M., Feltovich, P. and Glaser, R. 1981. Categorisation and representation of physics problem by experts and novices. *Cognitive Science*. 5, 121-152.

Clement, J. 1993. Using bridging analogies and anchoring intuitions to deal with students preconceptions in Physics. *Journal of Research in Science Teaching*. 30. 1241 – 1257.

Clement, J., Brown, D. and Zeitsman, A. 1989. Not all preconceptions are misconceptions: Finding "anchoring conceptions" for grouping instruction on students' intuitions. *International Journal of Science Education*, 11: 555-565.

Cook, S.W. and Selltiz, C.A. 1964. A multiple indicator approach to attitude measurement. *Psychology Bull*. 62.1: 36-55.

Coopersmith, S. A. 1959. A Method for Determining types of Self-esteem. *Journal of Abnormal and Social Psychology* 59: 87-94.

Corsini, R. J. 1994. *Encyclopedia of Psychology, 2nd ed.* New York: John Wiley. 86-89.

Costa, A. L. and Garmston, R. J. 1994. Cognitive Coaching: A foundation for Renaissance schools. Norwood MA Christopher-Cordon publishers, Inc.

Dantzig, G. B. 1963. Linear Programming Extensions. Princeton: Princeton University Press.

Davis, J. 2001. Conceptual change. Orey, M. Ed. Emerging perspectives on learning, teaching, and technology. Available Website: http://www.funderstanding.com/cognitive_coaching.cfm download: 5/2/2008.

Deardorff, M. D., Hamann, K. and Ishiyama, J. 2009a. Assessment in Political Science. Washington: American Political Science Association.-----.2009b."Introduction." In Assessment in Political Science, Deardorff, M. D. Hamann, K and Ishiyama, J. Eds. Washington: *American Political*

Dewey, J. 1938a. The Logic of Inquiry New York: Henry Holt.

Diefendroff, J. M., Hall, R. J., Lord, R. G. and Strean, M. L. 2000. Action state orientation: Construct validity of a revised measure and its relationship to work-related variables. *Journal of Applied Psychology*. 85. 250 – 263.

Dill, K. E., Brown, B. P. and Collins, M. A. 2007. Effects of Media Stereotypes on Sexual Harassment Judgments and Rape Supportive Attitudes: Popular Video Game Characters, Gender, Violence and power. *Manuscript in Preparation.*

diSessa, A. A. 1982. Understanding Aristotelian Physics: A case study of knowledge-based learning. *Cognitive Science*. 37-75.

diSessa, A., Hammer, D., Sherin, B. and Kolpakowski, T. 1991. Inventing graphing: Meta-representational experience in children. *Journal of Mathematics Behavior*. 10:117-160.

diSessa, A.A. 1993. *Towards an Epistemology of Physics Cognition and Instruction.* 10.2 & 3: 105-225.

Douglas, K. D. 2007. Intelligence. Microsoft Encarta Student 2008 DVD

Driver, R. and Easley, J. A. 1978. Pupils and Paradigms: *A Review of Literature Related to Concept Development in Adolescent Science Students Studies in Science Education* 5: 61-84.

Duit, R. 1999. Conceptual change approaches in science education. In Schnots, W., Vosniadou, S and Carretero, M. Eds. *New perspectives on conceptual change.* kidlington, Oxford: Elsevier Science.

Duit, R. 1999. Conceptual Change Approaches in Science Education. Schnotz, W. Vosniadou, S. and Carretero, M. Eds. *New Perspectives on Conceptual Change* 263-282. Oxford: Pergamon.

Duru, M. K. and Gurdal, A. 2002. The effects of concept mapping on students achievement. in proceedings of the V National Conference on science and mathematics education.

Earl, Lorna. 2004. Assessment as Learning: Using Classroom Assessment to Maximize Student Learning. Thousand Oaks, CA: Corwin Press.
"Goals of Essential Studies at UND." n.d. Available at

http://www.und.edu/dept/registrar/EssentialStudies/ESGoalsatUND.html (last visited February 2, 2009).

Edwards, J. L. 1993. The effect of cognitive coaching on the conceptual development and reflective thinking of first year teachers. *Dissertation Abstracts International*. 40:12. (University Microfilms No. 93-20751).

Edwards, J. L. 2005. Research on cognitive coaching excepted from cognitive coaching: A synthesis of the Research on 28/6/2010.

Edwards, J. L. and Green, K. E. April,1999. "Growth and coaching skills over a 3 year period: Progress toward mastery". AERA: Montreal.

Elliot, A. J. and Church, M. A. 1997. A hierarchical model of approach and avoidance achievement motivation. *Journal of Personality and Social Psychology*. 72. 218 – 232.

Ellison, J. and Hayes, C. 2006. Effective school leadership: Developing principals through cognitive coaching: Norwood, M. A.: Christopher-Gordon. Book study questions (PDF file).

Encyclopedia Americana International Edition. Scholastic Library Publishing, Inc. Danbury, Connecticut. 1:40.

Encyclopedia Americana International Edition. Scholastic Library Publishing, Inc. Danbury, Connecticut. 17:56.

Erekosima, I. A. 1996. Personality factors in study habit and social adjustment among adolescent learners in Rivers State of Nigeria. Unpublished Ph. D. Thesis. University of Calabar, Calabar.

Erickson, G. 1980. Children's viewpoint of heat. *Science Education* 64: 323-338.

Erten, S. 2000. *Empirische Undersuchungen zu Bedingungen der Umwelterziehung-Ein interkultureller Vergleich auf der Grundlage der Theorie des geplanten Verhaltens*, Tectum Verlag, Marburg.

Eylon, B. and Linn, M. C. 1988. Research perspectives in science education. *Review of Educational Research.* 58. 251-301.

Falk, J. H. and Dierking, L. D. 2000. Learning from museum: Visitor experiences and the making of meaning. Walnut Creek, CA: AltaMira Press.

Falk, J. H. and Dierking, L. D. 1992. The museum experience. Washington DC: Whalesback Books.

Federal Ministry of Education (FME). 2004 National Policy on Education, 4th ed. NERDC press Yaba-Lagos. Nigeria.

Fortner, R. W. and Mayer, V. J. July, 1998. Learning about the earth as a system. Proceeding of the Second International Conference on Geoscience Education. Hilo HI.

Fox, R., Luszaki, M. B. and Schmuck, R. 1966. Diagnosing Classroom Learning Environments Chicago: *Science Research.* 90.

Fox-Keller, E. 1983. A feeling for the organism: The life and work of Barbara. McClintock. New York: W.H Freeman.

Francisco, J., Peralta, S., Maria, D. and Sanchez, R. 2003. Relationship between self-concept and academic achievement in primary students. *Electronic Journal of Research in Educational Psychology and Psychopedagogy.* 1.1: 95-120.

Garner, R. 1987. Metacognitive and Reading Comprehension. Ablex Publishing, Norwood NJ.

Gentner, D. and Gentner, D. R. 1983. Flowing Waters or Teeming Crowds: Mental Models of Electricity. In Gentner, D and Stevens, A.L. Eds. Mental Models. Hillslade, NJ: Earlbaum.

Georghiades, P. 2000. Beyond conceptual change learning in science education: Focusing on transfer, durability and metacognition. *Educational Research*, 42, 119-139.

Gilbert, J. K. and Osborne, R. J. 1980. Identifying Science Students' Concepts: The interview-about-instance approach. Archenhold, W. F. et al Eds. *Cognitive Development Research in Science and Mathematics Leeds*: University of Leeds printing service.

Ginsburg, H. and Opper, S. 1979. Piaget's Theory of Intellectual Development Englewood Cliffs NJ: Prentice-Hall.

Glaser, R. and Chi, M. T. 1988. An Introduction to Radical Constructivism. Watlawick, P. Ed. *The invented reality*. New York: W.W Norton.

Glaserfeid, E. V. 1984. An Introduction to Radical Constructivism. Watlawick, P. Ed. The invented reality. New York: W.W Norton.

Gollwitzer, P. M. and Brandsta''tter, V. 1997. Implementation intentions and effective goal puisuit. *Journal of Personality and Social Psychology*. 73. 186 – 199.

Gooding, D., Pinch, T. and Schaffer, S. Eds. 1989. The uses of experiment: Studies in the natural sciences. Cambridge: Cambridge University Press.

Goodwin, C. 1997. The blackness of black: Color categories as situated practice. Resnick, L. B, Saljo, R. Pontecorvo, C. and Burge, B. Eds. *Discourse, Tools, and Reasoning: Essays on Situated Cognition* 111-140. Berlin: Springer-Verlag.

Gordan, C. and Gergen, K. 1968. The Self in Social Interaction New York: Wiley.

Gould, Stephen Jay. 1981. *The Mismeasure of Man*. New York and London: W. W. Norton & Co.

Griffin, C., Malone, L. and Kameenu, I. 1995. Effects of graphic organizer instruction on fifth-grade students. *Journal of Education Research*. 89:2. 98-107.

Gruber, H. E. and Voneche, J. J. Eds. 1977. The essential Piaget. New York: Basic Books.

Guay, F., Marsh, H. W. and Boivin, M. 2003. Academic self-concept and academic achievement: Developmental perspectives on their causal orderly. *Journal of Educational Psychology*. 95. 1: 124-136.

Halhoun, I. A. and Hestenes, D. 1985a. The Initial Knowledge State of Physics. *American Journal of Physics*. 53: 1043-1055.

Halhoun, I. A. and Hestenes, D. 1985b. Common Sense Concepts About Motion. *American Journal of Physics*. 53:1056-1065.

Hammer, D. 2000. Student resources for learning introductory physics. *American Journal of physics, Physics Education Supplement* 68: S52-S59.

Hammer, D. M. 1991. Defying Commonsense: Epistemological beliefs in an Introductory Physics Course. Doctoral Dissertation. University of California, Berkeley.

Hansford, B. C. and Hattie, J. A. 1982. The relationship between self-concept and achievement/performance measures. *Review of Educational Research*. 52: 123-142.

Harlen, W. 2004. Evaluating inquiry-based science developments, National Academy of science, available online http://www.nsrconline.org/pdf/NAS eval inquiry science.pdf.

Harter, S. 1986. Processes underlying children's self-concept. In J. Suls Ed. sociological perspectives on the self. III. Hillslade, New Jersey: Lawrence Erlbaum Associates.

Hayes, D. A. 1987. The potential for directing study in combined reading and writing activity. *Journal of Reading Behaviour*. 19: 333 – 398.

Hewson, P. W. 1981. A Conceptual Change Approach to Learning Science. *European Journal of Science Education*. 3: 383-398.

Hewson, P. W., Beeth, M. E. and Thorley, N. R. 1998. Teaching for Conceptual Change. Tobin, K. G. and Fraser, B. J. Eds. *International*

Handbook of Science Education. 199-218. Dordrecht Netherland: Kluwer Academic publishers.

Hossein, A. 1999. The Classical Simplex Method. Available online http:// www.mirrorservice.org/sites/home.ubalt.edu/ntsbarsh/Business-stat/home.html. Retrieved on 30/12/2010.

Huffman, K., Vernoy, M., Williams, B. and Vernoy, J. 1991. *Psychology in Action 2nd*. New York: John Wiley & sons.

Ifemuyiwa, S. A. 1998. Correlates of academic performance in secondary school mathematics. *Studies in Curriculum.* 2: 30-38.

Ige, T. A. 1998. Concept mapping and problem-solving teaching strategies as determinants of learning outcomes in secondary school Ecology in Nigeria. Unpublished Ph.D Thesis. University of Ibadan, Ibadan.

Inhelder, B. and Piaget, J. 1958. The Growth of Logical Thinking from Childhood to Adolescence: An essay on the Construction of Formal Operational Structures London: Routledge.

Inhelder, B. and Piaget, J. 1959. Judgment and reasoning in the child. London Routledge & Kegan Paul.

Jacob, F. 1995/1987. The statue within. Plainview, NY: Cold Spring Harbor Laboratory Press.

Jean Piaget 1967. *Logique et Connaissance scientifique*. Encyclopedie de la Pleiade.

Jegede, J. O. 1982. An evaluation of the Nigerian Integrated Science Project (NISP) after a decade of use in the classroom. *International Review of Education.* 28: 321-336.

Jegede, J. O. and Okebukola, A. P. 1986. Possible Solutions to Students Underachievement in Science a Cross Sectional View of the Nigerian Society. *Proceedings of Science Teachers Association of Nigeria.* Mushin, Nigeria: Akin Bolutife printers.

Jegede, J. O. and Okebukola, P. A. 1992. Differences in Socio-cultural Environment Perceptions Associated with Gender in Science Classrooms. *Journal of Research in Science*.

Jerome, S. Bruner 1964. The Process of Education. Cambridge, mass: Harvard University press, 1960. Robert, M. Gagne, The conditions of learning New York: Holt, Rinehart and Winston, 1977; and Jean Piaget, "cognitive development in children: Development and learning**".** *Journal of Research in Science Teaching*. 2: 176-186.

Jim Fay 2008. Shaping self-concept-encouraging kids to take risks and learn. The Love and Logic Press. Inc.

Jimenez-Aleizandre, M. P., Rodrrignez, A. B. and Duschl, R. A. 2000. "Doing the lesson" or Doing science": Argument in high school genetics. Science Education. 84: 757-792.

John, C. P., William, J. W. and Stephen, S. W. 1998. College Mathematics through Applications. Delmar publishers Inc. Jossey-Bass. Sum & Light, 14.

Joyce, B. and Showers, B. 1995. Student achievement through staff development: *Fundamentals of School Renewal*. 2nd ed, White Plain, N.Y.: Longman.

Kadvany, J. 2002. "Review of Stephen Wolframs A New Kind of Science". www.math.uf.edc/edark/kadvany_Review_ANKS.html.

Kali, Y., Orion, N. and Eylon Bat-Sheva 2003. Effect of knowledge integration activities on students' perception of the earth's crust as a cyclic system. *Journal of Research in Science Teaching*. 40.6: 545-565.

Kaplus, R. 2003. Science teaching and the development of reasoning. *Journal of Research in Science Teaching*. 40: S51-S57.

Kaya, A. and Siyes, D. M. 2008. Sociometric status and life satisfaction among Turkish elementary schools students. *Egidim Arastimalari-Eurarian Journal of Educational Research*, 32, 69-82.

Keselman, A., Kanfman, D. R., Kramer, S. and Patel, V. L. 2006. Fostering conceptual change and critical reasoning about HIV and AIDS. Journal of Research in Science Teaching. 44.6: 844-863.

King, A. 1991. Effects of training in strategic questioning on children's problem-solving performance. *Journal of Educational Psychology*. 83: 307 – 317.

Koestler, A. 1972. The roots of conscience. New York: Vintage Books.

Kuhn, T. S. 1996. The Structure of Scientific Revolutions. 3rd ed. University of Chicago Press.

Kuhn, T.S. 1970. The Structure of Scientific Revolutions. Chicago University of Chicago.

Kuppuswany, B. 2007. Advance Educational Psychology. Sterling Publishers Private Limited. A-59, Okhia Industrial Area. Phase II, New Delhi.

Lang, P., Katz, Y. and Menezes, I. 1998. Affective education: A comparative view. London: Cassell.

Latour, B. and Wootgar, S. 1986. Laboratory life: The social construction of scientific facts. Princeton: Princeton University Press.

Lawrence, D. 1988. Enhancing Self-esteem in the Classroom. London: Paul Chaptman pub LTD.

Lazarowitz, R. and Tamir, P. 1994. Research on using laboratory instruction in science. Gabel, D. L. Ed. *Handbook on research on science teaching and learning.* New York Macmillan. 94-128.

Lee, O. and Fradd, S. 1996. International Patterns of Linguistically Diverse Students and Teachers: *Insights for Promoting Science Learning Linguistics and Education*. 8: 269-297.

Lee, O. and Fradd, S. 1998. Science for all, including students from non-English-language backgrounds. *Educational Researcher*. 27.4: 12-21.

Lee, O., Fradd, S. and Sutman, F. 1995. Science knowledge and cognitive strategy use among culturally and linguistically diverse students. *Journal of Research in Science teaching*. 32: 797-816.

Lehrer, R. and Schauble, L. in press 1989. Modeling in Mathematics and Science. Glaser, R. Ed. *Advances in Instructional Psychology* 5. Mahwah. NJ: Eribaum.

Lewis, E. L. 1991. The Process of Scientific Knowledge Acquisition of Middle School Students Learning Thermodynamics. Doctoral dissertation. University of California, Berkley.

Lorch, R. F., Lorch, E. P. and Klusewitz, M. A. 1993. College students conditional knowledge about reading. *Journal of Educational Psychology:* 85. 239 – 252.

Lynch, M. 1985. Art and artifact in laboratory science: A study of shop work and shoptalk in a research laboratory. Boston: Routledge & Kegan Paul. M. D., Hamann, K. and Ishiyama, J. Eds. Washington: *American Political Science Association*, 17-37.

Mani, T. C. 1982. "The gap between the intended and the operational forms of the Nigerian Integrated Science Project (NISP) Curriculum". Paper presented at the 23rd Annual conference of the Science Teachers Association of Nigeria (STAN) Makurdi.

Marsh, H. W. 2003. A reciprocal effects model of the causal ordering of academic self-concept and achievement. Paper presented at NZARE AARE, Auckland, New Zealand November, 2003. MAR03755.

Mayer, V. J. Ed. 2002. Global science literacy. Dordrecht: Kluwer Academic.

McCloskey, M. 1983. Naïve Theories of Motion. Genter, D. and Stevens, A. Eds. *Mental Models* 299-323. Hillsdale NJ: Eribaum.

McDermott, J. J. 1981. The Philosophy of John Dewey Chicago: University of Chicago press.

McDermott, L. C. 1984. Research of Conceptual Understanding in Mechanics. *Physics Today*. 37: 24-32.

McGuire, W. J. 1986. The vicissitudes of attitudes and similar representational constrains in twentieth century psychology. *European Journal of Social Psychology*. 16.2: 89-130.

Melani, F., Gratteri, P., Adamo, M. and Bonaccini, C. 2001. FILO (Field Interaction Ligand Optimization): A simplex strategy for searching the optimal ligand interaction field in drug design. Journal of Computer-Aided Molecular Design, 15.1: 57-66

Michaels, S. and Sohmer, R. 2000. Narratives and inscriptions: Cultural tools, power and powerful sense making. Cope, B. and Kalantzis, M. Eds. *Multi-literacies* 267-288. London: Routledge.

Mili, L., Tang, T. and Wand, L. 2003. Directing orbits of chaotic dynamical systems based on simplex-annealing strategy IEEE Int. Conf. Neural Networks & Signal Processing Nanjing, China, December. 14-17.

Miller, P. H. 1985. Metacognition and attention. In Forrest-Pressley, D. L., McKinnon, E. G. and Waller, I. G. Eds. *Metacognition, cognition and Human Performance.* Academic Press, New York. 181 -122.

Moffit, R. 2001. Policy intervention, low-level equilibra and social interactions. In *Social Dynamics* S. Duflauf and H. P. Young Eds. Cambridge Mass: MIT press, 45-82.

Moon, J. 2002. *The Module and Programmes Development Handbook.* London, Kogan 45-57.

Morel, P. D. and Lederman, N. G. 1998. Students attitudes toward school and classroom science: Are they different phenomena? *School Science and Mathematics.* 98.2: 76 – 83.

Mortimore, P., Sammons, P. and Stoll, L. 1988. School matters. University of California Press, Berkeley, California.

Mullis, Ina V. and Lynne, B. Jenkins. 1988. The Science Report Card: *Elements of Risk and Recovery. Trends and Achievement based on the 1986 National Assessment.* Princeton, NJ: Educational Testing Service. As cited in Seymour 1992b. 230-231.

Myers, D. 2003. Psychology in Modules, (7th ed.) New York: Worth. ISBN 0-7167-5850-4.

National Research Council (NRC). 2000: National Science Education Standards Washington DC, National Academy Press.

National Science Board. 2002. Science and Engineering Indicator: Science and technology: public attitudes and public understanding. Washington DC: US. Government Printing Office.

NECUSE, 2005. Achieving gender equity in science classrooms. Brown University. Available online. Retrieved on 3/5/2008.

Nelson, K. 1977. Cognitive development and the acquisition of concepts. Anderson, R. C. Spiro, R. J and Montaque, W. E. Eds. Schooling and the acquisition of knowledge. Hillsdale NJ: Lawrence Eribaum Associates.

Nemirovsky, R., Tieney, C. and Wright, T. 1998. Body motion and graphing. *Cognition & Instruction*. 16: 119-172.

Neo, H. I., Khiang, C. C., AbdulRahim, R., Hui, R. T., Hoong, R. C and Naidu, R. 2000. Effectiveness of Inquiry Based Approach in students' understanding of science concepts. In Life sciences in the primary science syllabus. *Science unit, sciences branch,* CODD, Ministry of Education Singapore.

Nigerian Educational Research and Development Commission (NERDC). Nov 15, 2007. NERDC releases UBE curriculum, makes civic education compulsory 23. Nigerian Tribune. Retrieved Mar 14, 2008.

Njoku, Z. C. 1987. The Nigerian Educational Research Council: Future Direction for African Education Monograph, Lagos: NERC pronn.

Novak, J. 1990. Concept maps and Vee diagrams: Two cognitive tools to facilitate meaningful learning. *Instructional Science* 19: 29-52.

Novak, J. D. A. 1977. *A theory of education*. Ithaca: Cornell University Press.

Novick, S. and Nussbaum, J. 1978. Junior high school pupils' understanding of the particulate nature of matter: An interview study. *Science Education.* 62: 273-281.

Nussbaum, J. and Novick, N. 1982. Alternative Frameworks, Conceptual Conflict, and Accommodation: *Toward a Principled Teaching Strategy Instructional Science.* 11: 183-200.

O'Connor, J. and McDermott, I. 1997. The Art of Systems Thinking. San Francisco: Thorsons.

Ochs, E., Jacoby, S. and Gonzales, P. 1996. "When I come down I'm in the domain state": Grammar and graphic representation in the interpretive activity of physicists. Ochs, E. δchegloff, E.A and Thompson, S. Eds. *Interaction and Grammar* 328-369. New York: Cambridge.

Odinko, M. N. and Adeyemo, D. A. 1999. Socio-psychological factors as correlates of senior secondary students attitude towards English Language. Evaluation in Africa in Honour of E.A. Yoloye. Ibadan: Stiring-Horden publishers (Nig) Ltd. 233-239.

Odubunmi, E. O. 1986. Pre-service science and technical teachers' attitude towards the teaching of Integrated science and teaching methods employed by them. *Journal of Science Teachers' Association of Nigeri.*, 24.1,2: 209-217.

Odubunmi, E. O. and Balogun, T. A. 1991. The Effect of Laboratory and Lecture Teaching Methods on Cognitive Achievement in Integrated Science. *Journal of Research in Science Teaching*. 28.1: 213-234.

Odunusi, T. O. 1984. A Study of the Attitude of some Nigerian Science Students toward Science and Science Teaching. *Journal of Science Teachers Association of Nigeria*. 22. 2: 116-122.

Odunusi, T. O. 1997. Diagnosis and remediation of science concept related weakness among Nigerian school children. Education challenges in Africa for the 21st century. *A Book of Reading for the World Council for Curriculum and Instruction.* Akoka-Lagos. Jas publisher. 33-38.

Ogunbiyi, J. O. 2007. Effects of values clarification strategies on in-service teachers environmental knowledge and attitude in selected secondary schools in Abeokuta, Ogun State. *African Journal of Education Researc*h, June/December 2007, 22(1&2): 10-14.

Ogunkola, B. J. 2002. Instructor-expressiveness, students locus of control and cognitive entry behaviour as measures of students achievement in and attitude towards biology. Ph.D. Thesis. University of Ibadan, Ibadan.

Ogunniyi, M. B. 1982. An analysis of prospective science teachers' understanding of the nature of science teaching. *Journal of Science Teachers' Association of Nigeria*. 19.1: 25-32.

Ojo, M. O. 1989. The differential effectiveness of cooperative, competitive and individual's goal structures on students' performance in Chemistry. Ph D. Thesis. Dept of Teacher Education. University of Ibadan.

Okebukola, P. A. O. 1984. The relative effectiveness of co-operative and competitive interaction techniques in strengthening students' performance in science classes. Science Education. 4. 2: 219-224.

Okpala, N. P. 1985. Teacher Attitudinal variables in Instructional Assessment practices as correlates of learning outcomes in Physics. Ph D. Thesis. University of Ibadan.

Okwilagwe, E. A. 2001. Patterns of undergraduates attitude to academic work. In Awosika. Y. Babalola, J. F., Fabunmi, M., Osiki, J. O. and Emunemu, B. O. Eds. Tropical issues in education: papers in honour of Professor C. O. Udoh. Codat publications Ibadan. 73-81.

Olagunju, A. M., Adesoji, F.A., Ireogbu, T.O. and Ige, T.A. 2003. Innovations in science teaching for the New Millennium. Oluremi Ayodele-Bamisaiye, Nwazuoke, I.A. and Okediran, A. Eds. Education this Millennium-innovations in theory and practice. Macmillan Nigeria.

Omotayo, K. A. and Olaleye, F. O. 2008. Affective science teaching: A method to enhance qualitative science education in Nigeria. The social sciences. *Medwell Journals online*. 3:4. 322-326. Retrieved on 2nd October, 2009.

Onocha, C. O. 1985. Patterns of relationship between school factors and pupils learning outcomes in Bendel state primary school project. Ph D. Thesis. University of Ibadan.

Onocha, C. O. and Okpala, N. P. 1985. What Anambra State secondary school senior prefer in their science teachers. *Journal of Nigeria Education Research Association*. 4.2 & 3: 44-52.

Onwu, G. O. M. 1981. Learning difficulties in Chemistry: Capacity limitation or strategy deficit. *African Journal of Educational Research*. 4.1: 20 125.

Orion, N. 1998. Implementation of New teaching strategies in different learning environment within the science education. *Proceedings of the International Conference of Secondary Education in Portugal: Shaping the Future: Politics Curricula Practices.* Evora, Portugal: Ministry of education. 125 – 139.

Osborn, R. J. and Wittrock, M. C. 1985. The generative learning model and its implications for science instruction. *Studies in science education.*

Osokoya, M. M. 1998. Some determinants of secondary school students academic achievement in Chemistry in Oyo State. PhD. Thesis. Institute of Education. University of Ibadan.

Ossimitz, G. August, 2000. Teaching System Dynamics and System Thinking in Austria and Germany. *Proceedings of the 18th International Conference of the System Dynamics Society*. Bergen, Norway.

Osuafor, A. M. 1999. Extent of use of Research findings on structural strategies in science Education. *Journal of Science Teachers' Association of Nigeria*. 34.1 & 3: 102-112.

Pajares, F., Britner, S. L. and Valiante, G. 2000. Relation between achievement goals and self-beliefs of middle school students in writing and science. *Contemporary Educational Psychology*. 25: 406-422.

Parajes, M. F. and Schunk, F. 1992. Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research*. 62: 307 – 332.

Palmer, D. 2001. Students alternative conceptions and scientifically acceptable conceptions about gravity. International Journal of Science Education. 23: 691-706.

Palomba, C. A. and Banta, T. W. 1999. Assessment Essentials: Planning, Implementing, Improving Assessment in Higher Education. New York:

Pankratius, W. J. 1990. Building an organized knowledge base concept mapping and advert in secondary school physics. *Journal of Research in science teaching*. 27.4: 315-333.

Patterson, C. H. 1971. An Introduction to Counseling in the School New York: Harper and Row.

Pena, A. and Paco, O. 2004. Attitudes and view of Medical students towards science and pseudoscience. Med Educ Online (series online); 9:4 Available from http://www.med.ed-online.org

Piaget, J. 1967. The mental development of the child. Elkind, D. Ed. Six psychological studies. New York: Random House.

Piaget, J. 1970. The Child's Conception of Movement and Speed New York: Basic Books.

Pinel, J. 2005. Biosychology 6th ed. Boston: Allyn and Bacon.

Pines, A. L. and West, L.H.T. 1986. Conceptual understanding and service learning: An interpretation of research within a source of-knowledge framework. *Science Education*. 70: 583-604.
Political Science Association, xi-xiii.

Popooola, A. A. 2002. *Effects of Heuristic Problem-Solving and Programmed Instructional Strategies on Senior Secondary School Studentts' Learning Outcomes in Mathematics in Ekiti State, Nigeria.* Upublished Ph.D Thesis, University of Ibadan.

Posner, G. J. and Gertzog, W. A. 1982. The Clinical Interview and the Measurement of Conceptual Change. *Science Education.* 66. 2: 211-227.

Posner, G. J., Strike, K. A., Hewson, P. W. and Gertzong, W. A. 1982. Accommodation of a Scientific Conception: Towards a Theory of Conceptual Change. *Science Education*. 66.2: 211-227.

Pottebaum, S. M., Keith, T. Z. and Ehly, S. W. 1986. Is there a causal relation between self-concept and academic achievement? *Journal of Education Research.* 79.3:, 140-144.

Potworowski, J. A., Felio G. Y. and LaVene Palmer, J. H. 2008. Application of Creative Problem Solving Process to R&D Planning: A case study in Urban Roads. *Technology Research*. 76- 85.

Pressley, M., Borkowsky, J. G. and Schneider, W. 1987. Cognitive strategies: Good strategy users coordinate metacognition and knowledge. In Vasta, R. and Whitehurst, G. Eds, *Annals of Child Development*, JAI Press, Greenwich, CT 5, 89 – 129.

Raimi, S. M. 2002. Problem-solving technique and laboratory skills as supplements to laboratory teaching in senior secondary school students learning of volumetric analysis. PhD. Thesis. University of Ibadan.

Resnick, L. B. 1981. *Instructional Psychology Annual Review of Psychology*. 32: 659-704.

Resnick, L. B. 1983. Mathematics and Science Learning: *A New Conception Science.* 220: 477-478.

Rheinberger, H. 1997. Toward a history of epistemic things: synthesizing proteins in the test tube. Stanford, CA: Stanford University press.

Reynolds, R. E. 1992. Selective attention and prose learning: Theoretical and empirical research. *Educational Psychology Review.* 4: 345 – 391.

Richard, J. 2005. Discrete Mathematics. 6th ed. Pearson Educational International Prentice Hall.

Root-Bernstein, R. S. 1989. How scientists really think. *Perspectives in Biology and Medicine.* 32: 472-488.

Roschelle, J. 1991. Students' construction of qualitative physics knowledge: Learning about velocity and acceleration in a computer microworld. Unpublished doctoral dissertation, University of California, Berkerley.

Roschelle, J. May, 1994. Collaborative Inquiry: Reflections on Dewey and Learning Technology. *The Computing Teaching*. 3-9.

Rosebery, A. S. and Warren, B. 1999. Supporting teachers to develop theories of children in the particular. Paper presented at the Conference on Teacher Change, National Center for Improving Student Learning and Achievement, University of Wisconsin, Madison.

Rosebery, A., Warren, B. and Conant, F. 1992. Appropriating Scientific Discourse: Findings from Language Minority Classrooms. *Journal of the Learning Science.* 2: 61-94.

Ryan, R. and Deci, E. 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychology*. 55. 68 – 78.

Salami, S. O. 1987. Effects of Mastery Learning and Counseling on Learning Outcomes in Chemistry. PhD. Thesis. University of Ilorin.

Salami, A. M. 2005. Correlates of self-esteem, academic self-concept and locus of control on students attitude towards schooling. Ph. D Thesis. University of Ibadan.

Samuel, S. C. 1978. Enhancing Self-concept in Early Childhood London: America science press.

Saunders, J. 2000. The practice of clinical medicine as an art and as a science. *Journal of Medical Ethics.* 26: 18-22.

Schechtman, Z. and Leichtentirtt, J. 2004. Affective teaching: A method to enhance classroom management. *European Journal of Teaching Education*. 27: 323-333.

Schneider, W. and Pressley, M. 1989. Memory Development Between 2 and 20.Springer-Verlag. New York.

Science Teachers Association on Nigeria (STAN). 1999. Nigerian Integrated Science Project Book Three New edition. Heinemann educational books (Nigeria) Plc. *Science Association.*, 3-16.

Scott, P. H., Asoko, H.M. and Driver, R.H. 1991. Teaching for Conceptual Change: A review of Strategies. Duit, R. Goldberg, F. and Niedderer, H. Ed. Research in Physics Learning: Theoretical Issues and Empirical Studies Kiel, Germany: IPN.

Serin, G. 2002. Laboratory in science education. *Science Education Symposium*, Maltepe University. S. 403-406.

Shaw, M., Edson, K. and Bell, H. 1960. The Self-concept of bright Underachieving High School Students as revealed by an Adjective Checklist. *Personnel and Guidance Journal.* 39: 193-196.

She, H. C. Dec, 2001. Dual Situated Learning Mode: An International Approach toward Scientific Conceptual Change. *Proceedings of 2001 Taiwan Japanese Symposium in Science Education.* Taipei, Taiwan.

She, H. C. 2003. DSLM Instructional Approach to Conceptual Change involving Theoretical Expansion. *Research in Science and Technological Education.* 21: 43-54.

Skocpol, T. 2009. “Foreward.” In Assessment in Political Science, Deardorff, M. D., Hamann, K. and Ishiyama, J. Eds. Washington: *American*

Smith, J. P., diSessa, A. A. and Roschelle, J. 1993. Misconceptions Reconceived: A Constructivist Analysis of Knowledge in Transition. *Journal of the Learning Sciences*. 3.2: 115-163.

Smith, C., Carey, S. and Wiser, M. 1985. On differentiation: A case study of the development of the concepts of size, weight and density. *Cognition*, 21, 177-233.

Spohrer, J. C., Soloway, E. and Pope, E. 1989. A Goal/Plan Analysis of Buggy Pascal Programmes. In Soloway, E. and Spohrer, J. C. Eds. Studying the Naïve Programmer. Hillslade, NJ: Lawrence Earlbaum Associates. 355-399.

Stanford-Binet. 1916. Intelligence tests. Retrieved from "http://en.wikipedia.org/wiki/Stanford-Binet_Intelligence_Scales" on 15 March 2009.

Stanovich, K. E. 1990. Concepts in developmental theories of reading skill: Cognitive resources, automaticity, and modularity. *Developmental Review*. 10: 72 – 100.

Sternberg, R. J. 1986. The triarchic mind: Anew theory of human intelligence. Penguin Books, New York.

Sternberg, M and Clement, J. 1997. Constructive model evolution in the study of electric circuits. Abrams, R. Ed. *Proceeding of the fourth International Seminar on Misconceptions Research*. Santa Cruz. CA: meaningful Learning Research Group.

Strike, K. A. and Posner, G. J. 1985. A Conceptual Change view of Learning and Understanding. West LHT and Pines, A. L. Eds. Cognitive Structure and Conceptual Change. New York: Academic press.

Strike, K. A. and Posner, G. J. 1992. A Revisionist Theory of Conceptual Change. Duschi, R. and Hamilton, R. Eds. *Philosophy of Science, Cognitive Psychology and Education Theory and Practice*. 147-176. Albany, NY: SUNY.

Talton, E. L. and Simpson, R. D. 1986. Relationships of attitudes toward self, family, and school with attitudes toward science among adolescents. *Science Education.* 70.4: 365 – 374.

Tamir, P., Nussinovitz, R. and Friedler, Y. 1982. The design and use of a practical tests assessment inventory. *Journal of Biological Education.* 16.1: 42-49.

Tesser, A. and Shaffer, D. R. 1990. Attitudes and attitude change. *Annual Review Psychology*. 41: 479-523.

The Encyclopedia Americana International Edition. 2003. GROLIER, An Imprint of Scholastic Library Publishing Danbury Connecticut. 24: 385-386.

The World Book Encyclopedia. 2006. S-Sn. A Scott Fretzer Company Chocago. 17: 191-192.

Torsten Husen and Posllethwaite. 1994. The International Encyclopedia of Education 2nd edition Pergamon. 1:1-5.

Torsten Husen and Posllethwaite. 1994. The International Encyclopedia of Education 2nd edition Pergamon. 8:19-23.

Trend, D. 2001. Deep time framework: A preliminary study of UK primary teachers' conceptions of geological time and perceptions of geosciences. *Journal of Research in Science Teaching.* 38: 191-221.

Trohrbridge D. E. and McDermott L. C. 1980. Investigation of Student Understanding of Acceleration in one Dimension. *American Journal of Physics*. 50: 242-253.

Trundle, K. C., Atwood, R. K. and Christopher, J. E. 2007. A longitudinal study of conceptual change: pre-service elementary teachers' conceptions of moon phases. Journal of Research in Science Education. 44.2: 303-326.

Udousoro, U.J. 2002. *The Relative Effects of Computer and Text-Assisted Programmed Instruction on Students' Learning Outcomes in Mathematics.* Unpublished Ph.D Thesis, University of Ibadan.

University of Exeter, 2004. TQA Manual, Learning and Teaching Definitions, http://www.ex.ac.uk/admin/academic/tls/tga/modapp 1.htm Last updated 31 August 2004.

Vallerand, R. J. 2000. Deci and Ryan's self-determination theory: A view from the hierarchical model of intrinsic and extrinsic motivation. *Psychological Inquiry*. 11. 312 -318.

VandeWalle, D. M., Brown, S. P., Cron, W. L. and Slocum, J. W. 1999. The influence of achievement goals and self-regulation tactics on sales performance: A longitudinal test. *Journal of Applied Psychology*. 84. 249 -259.

Vankus, P. 2005. 'History and present of didactical games as a method of mathematics teaching'. Acta Didactica Universitatis Comenianae-Mathematics. 5. 53 – 68.

VanLehn, K. 1989. Mind Bugs: The Origins of Procedural Misconceptions. Cambridge, MA: MIT Press.

Vernon, P. E. 1978. The Structure of Human Abilities. 2nd ed. Greenwood. Westport, Connecticut.

Viennot, L. 1979. Spontaneous Reasoning in Elementary Dynamics. *European Journal of Science Education*. 1: 205-221.

Vispeol, W. P. 1995. Self-concept in artistic domain: An extension of the Shavelson/Huber and Standton (1976) model. *Journal of Education Psychology*. 87:134-153.

Voparil, C. J. 2009. "Assessing for Understanding: Toward a Theory of Assessment as Learning." In Assessment in Political Science, Deardorff, Von Glaserfeld, E. 1987. Learning as a constructive activity. In C. Janvier Ed. *Problems of Representation in the Teaching of mathematics.* Hillsdale, NJ: Erlbaum.

Von Glaserfeld, E. 1993. An exposition of constructivism: why some like it radical. Journal for Research in mathematics Education. 4, 19 – 30.

Von Glaserfeld, E. 1994. An introduction to radical constructivism.. watzlawick, P. Ed. The invented reality. New York: Norton.

Vosniadou, S. 2003. Exploring the relationships between conceptual change and intentional learning. In Sinatra, G. M. and Pintrich, P. R. Eds. *Intentional Conceptual Change.* Mahwah; NJ: Lawrence Erlbaum. 377-406.

Vygotsky, L. 1986. Thought and Language Cambridge, M.A: MIT press.

Warren, B. and Rosebery, A. 1996. "This question is just too easy!": Perspectives from the classroom on accountability in science. Schauble, L. and R. Eds. *Innovations in learning: New environments for education* 97-125. Hillsdale: Erlbaum.

Warren, B., Pothier, S., Ogonowski, M., Noble, T. and Goldstein, G. 2-3 Nov, 2000. Children's accounts of motion: Re-thinking the role of everyday experience. Presented at the NCISLA Seminar on Case Studies and Instructional Design, Ashland, MA.

West, L. H. T. and Pines, A. L. Eds. 1985. Cognitive Structure and Conceptual Change. New York: Academic Press.

Wigfield, A. and Karpathian, M. 1991. Who am I and what can I do? Childen's self-concepts and motivation in achievement situations. *Educational Psychologist.* 26: 233-261.

Wikipedia, 2010. Education. Retrieved: may 13, 2010 from http://en.wikipedia.org/wiki/Education.

Williams, R. L. and Cole, S. 1968. Self-concept and School. *Adjustment Personnel and Guidance Journal.* 46: 478-481.

Wolfram, S. 2003. “Book summary”. www.wolframscience.com/summary.

Young, C. C. 2009. “Program Evaluation and Assessment: Integrating

zi-wu REN, ye SAN and jun-feng CHEN. 2007. Hybrid simplex-improved genetic algorithm for global numerical optimization. National Natural Science Foundation of P. R. China (60474069). Available online 27 June 2007.

APPENDIX I

PROCEDURES ADOPTED FOR TRAINING THE TEACHERS

SIMPLEX STRATEGY (GROUP 1)

Topic: Tissue

Time: 80 minutes.

Duration: 1 week.

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

(i) define a tissue.

(ii) identify the major steps involved in simplex strategy.

(iii) carry out scientific investigation to verify the ideas about tissue.

(iv) state the importance of onion.

Previous Knowledge: Teachers have seen onion bulb before.

Instructional resources: Chart, flash cards, microscope, razor blade, onion bulb, water.

Procedure: Outlines steps for researcher and teachers activities on introduction, practice and lesson review.

Step	Researcher's activity	Teachers' activity
	Introduction: (Researcher)	**Teachers:**
1.	Introduces the objectives of the lesson by explaining what simplex is with example.	Listen to explanation.
2.	Leads teachers' to pick a topic (tissue) as a concept.	Participate in picking a topic.

3.	Introduces teachers' to the steps involved in simplex and explains what each step entails: i. Identification of process/ phenomenon/concept. ii. Fact finding about the concept iii. Concept definition. iv. Idea finding. v. Selecting and evaluating. vi. Planning vii. Selling of the idea viii. Action	Copy down the steps. Listen to explanations and ask questions for clarification.
4.	**Stimulus Practice (Researcher)** Groups teachers into 2 each, supplies each group with flash cards. Provides facts about tissue. Defines the concept (tissue). States the components of a tissue. Selects important components of onion bulb. Writes the ideas on flash cards and arrange them in order. Outlines procedures for identification of parts. Demonstrates activity on the ideas.	Form groups and listen to researcher. Listen, note down and participate in making points during the discussion.
5.	**Guided practice (Teacher)**	Teachers obtain an onion bulb.

	Researcher walks round to observe progress in each group and scores steps.	Teachers state facts about the onion bulb. Teachers identify the onion bulb. Teachers write ideas on flash cards Teachers select and arrange salient ideas in order. Teachers plan procedures to identify the parts of onion. Agree on the most appropriate procedure.
6.	**Evaluation** Researcher asks questions and leads a discussion on the merits and demerits of Simplex process. Highlights sources of information which can be used in simplex process such as laboratory work, field trips, home activities, film shows, printed texts, etc. Summarizes all the lessons taught on Simplex process and assigns project work to each group by applying Simplex process.	Carry out the selected procedure. Participate in the discussion. Listen to researcher Copy the assigned project.

COGNITIVE COACHING STRATEGY (GROUP 2)

Topic: Tissue.

Time: 80 minutes.

Duration: 1 week.

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

(1) define the term tissue.

(2) familiar with steps involved in cognitive coaching.

(3) identify main components of onion bulb.

(4) describe the relationships among the parts of onion.

(5) raise questions, clarify, describe the concept and make a self-appraisal on the knowledge gained.

Previous Knowledge: Teachers can read and write words.

Instructional resources: Extracts of reading texts, list of words on a cardboard, onion bulb.

Procedure: Outlines steps for researcher and teachers' activities on introduction, practice and lesson evaluation.

Step	Researcher's activity	Teachers' activity
	Introduction : (Researcher)	**Teachers':**
1.	Introduces the objectives of the lesson by explaining cognitive coaching with examples. Highlights steps involved in cognitive coaching Creates rapport by presenting a passage for teachers' to read and asks questions based on the passage: write down:	1. Listen to explanation 2. Read and study the passage 3. Express and write down the nouns, and verbs.

	(1) all the nouns in the passage (2) all the verbs	
2.	Mentions 3 words from the passage and requests teachers' to state what each word meant to them.	Make a list of the meanings of words.
3.	Leads teachers' in a discussion of meanings given by them.	Compare meanings and suggest reasons for variation.
4.	Brings teachers' attention back to the passage by asking them to read, reflect and attempt to: (a) list all the ideas, concepts and phrases so important to them (b) Gives meaning to the concepts.	Read passage again. Follow researcher's instruction to identify salient ideas.
5.	Allows teachers' to ask questions. Gives a passage on tissue in science text as follow-up activity for teachers' to read, and draw up the main ideas.	Ask questions, read and draw up main ideas.
1.	**Introduction : (Researcher)** Introduces the objectives of the lesson by explaining cognitive coaching with examples. Highlights steps involved in cognitive coaching Creates rapport by presenting a passage for teachers' to read and asks questions based on the passage: write down:	**Teachers':** 1. Listen to explanation 2. Read and study the passage 3. Express and write down the nouns, and verbs.

	(1) all the nouns in the passage (2) all the verbs	
2.	Mentions 3 words from the passage and requests teachers' to state what each word meant to them.	Make a list of the meanings of words.
3.	Leads teachers' in a discussion of meanings given by them.	Compare meanings and suggest reasons for variation.
4.	Brings teachers' attention back to the passage by asking them to read, reflect and attempt to: (a) list all the ideas, concepts and phrases so important to them (b) Gives meaning to the concepts.	Read passage again. Follow researcher's instruction to identify salient ideas.
5.	Allows teachers' to ask questions. Gives a passage on tissue in science text as follow-up activity for teachers' to read, and draw up the main ideas.	Ask questions, read and draw up main ideas.

	Stimulus Practice (Researcher)	
1.	Reads a passage, ask relevant questions and allows comments from teachers'.	Listen and answer researcher's questions.
2.	Lists main ideas in the passage on the board and defines them.	Listen and copy ideas and definitions.
3.	Highlights areas of importance in identification of ideas; Lists the main ideas as they connect one another and state their meaning.	Observe researcher's identification reflectively.
4	**Guided Practice** Researcher corrects teachers' thinking/ideas.	Teachers' form groups of 2 each. Teachers' read the provided passage from the science textbooks concerned with prerequisite concepts for the study. Teachers' draw up ideas and clarification in the passage about onion bulb.
5.	**Evaluation** Asks teachers' to swap work for scoring based on specific criteria. Researcher leads teachers' to state major ideas identified from the passage. These he writes on the	Teachers' define a tissue, describe the parts and write these in their workbook.

SCORING CRITERIA ON IDEAS IDENTIFIED FROM TEXT BY TEACHERS

S/N	DESCRIPTION	ADEQUATE		NOT ADEQUATE
		EXACTLY	CLOSELY	
1.	Identification of 5 main ideas from text.	1 x 5	½ x 5	0 x 5
2.	Definition of ideas	2 x 5	1 x 5	0 x 5

MODIFIED CONVENTIONAL METHOD (GROUP 3)

Topic: Tissue

Time: 80 minutes.

Duration: 1 week.

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

(1). define the concepts learnt (Tissue).

(2). describe the components of onion bulb.

(3). discuss relationships among components of onion bulb.

(4). report observations of practical demonstrations in the class.

(5). give specific examples of tissue.

Previous Knowledge: Teachers have seen different objects before.

Instructional resources: Charts showing onion bulb.

Procedure: Shown in researcher and teachers' activities below.

Step	Researcher's activity	Teachers' activity
	Practice : (Researcher)	**Teachers':**
1.	Writes the topic on the chalkboard. Asks questions to find out teachers' prior knowledge.	Answer questions.
2.	Gives relevant information about the topic (tissue) in term of definitions, descriptions and examples.	Listen to researcher.
3.	Shows a chart of onion bulb and reads the parts out.	Observe researcher's activities.
4.	Leads discussions on the features of onion	

	bulb. Clarifies any areas of doubt. Asks questions and reinforces teachers' responses.	Participate in answering questions.
5.	Summarizes the main ideas about the topic and gives follow-up activity.	Listen to explanation and write the chalkboard summary in their notebooks. Jot the follow-up activity

APPENDIX II

SIMPLEX STRATEGY (EXPERIMENTAL GROUP 1)

LESSON I

Topic: Habitats

Time: 40 Minutes

Instructional Materials: Charts of habitats with animals and plants, aquarium.

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

(a) define habitat

(b) list the kinds of habitats

Previous Knowledge: Students' can name:

(a) living things

(b) non-living things

Introduction: the teacher asks the students' to:

(a) think of and mention things around them

(b) name two living and two non-living things

Presentation: the teacher groups students' into 5 each. Teacher supplies each group with chart showing different habitats and flash cards. Teacher writes the topic on the board and defines habitat. Teacher tells students' to write on the flash cards four places where animals can live with examples.

Stimulus Practice: Teacher: (i) states the kinds of habitats and

(ii) defines the kinds of habitat.

Guided Practice: The Students': (i) select and arrange the flash cards of the living and non-living things that can be found in the two kinds of habitats.

(ii) Each group draws plans on what makes the animals to be found in the habitat.

(iii) The group agrees on a plan.

(v) Carry out activity using a chart or selecting a specific habitat.

Evaluation: Students': (i) asks questions and were discussed with the teacher moderating.

(ii) Teacher summarizes the correct procedure on the board.

(iii) Teacher scores steps

Follow-up activity: Students' are cardboard to construct an aquarium.

LESSON II

Topic: Biotic and Abiotic Factors

Time: 40 Minutes

Instructional Materials: Charts, Aquarium.

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

(a) mention 4 biotic factors

(b) name 4 abiotic factors

(c) count the number of living things in a habitat.

Previous Knowledge: Students' can give:

(a) the meaning of habitat

(b) the kinds of habitats

Introduction: Teacher asks the students' to mention 2 kinds of habitats.

Presentation: Teacher tells the students' to be in group of 5 each. Teacher supplies each group with a chart of the habitats and flash cards. Teacher tells students' to write 3 animals and 3 plants on the flash cards. Teacher writes the topic on the board.

Stimulus Practice: Teacher leads students' to identify from the charts:

(1) Two biotic factors and

(2) Two abiotic factors

Teacher defines: (i) biotic factor.

(ii) abiotic factor.

Guided Practice: Students' write the biotic and abiotic factors identified by each group on flash cards. The flash cards are selected and arranged according to kinds of habitats. Each group draws up plans on how to determine the number of biotic and abiotic factors. Each group agrees on which of the factors to be counted first. Students' count the number of plants and animals in each kind of habitats and write them on the flash cards.

Evaluation: Students ask questions for clarification. Teacher goes round to mark the arrangement of flash cards according to kinds of habitats. Students discuss results on the abiotic factors on the chat which the teacher summarizes on the board.

Follow-up Activity: Students' visit the school garden to count the number of any named plant.

LESSON III

Topic: Rusting

Time: 40 Minutes

Instructional Materials: Nails (rusted and rust-free), water, oil.

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

(a) define rusting

(b) state the conditions for rusting.

Previous Knowledge: Students' can name different kinds of non-living things and have metals and water around them.

Introduction: The teacher asks the students' to mention 2 non-living things at home.

Presentation: Teacher tells students' to form groups of five each. Each group is supplied with flash cards. Teacher writes the topic on the chalkboard. Teacher defines rusting.

Stimulus Practice: Teacher supplies the students' with the nails (rusted and rust-free), water, oil and test tube. The Teacher writes them on flash cards and arranges them on the chalkboard.

Guided Practice: Students: (i) suggest factors responsible for rusting and write them on flash cards.

(ii). Students' select and arrange the relevant factors.

(iii). Students' draw up plans on how to detect the causes of rusting on the flash cards.

(iv). Students' agree on a specific plan

(v). Students' carry out experiment to verify their ideas.

Evaluation: Teacher goes round to mark students' suggestions.

Students':

(a) define rusting

(b) state the conditions for rusting.

(c) Teacher summarizes the conditions for rusting on the board.

Follow-up Activity: Students' grease a nail or tin.

LESSON IV

Topic: Rusting and Burning

Time: 40 Minutes

Instructional Materials: test tube, nails, water, oil, paper, matches.

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

(a) compare rusting and burning

(b) state how rusting can be prevented.

Previous Knowledge: Students' can:

(a) define rusting

(b) state the conditions for rusting

Introduction: Teacher tells the students' to state what happens when wood burns.

Presentation: Teacher puts students' into groups of five each. Teacher supplies each group with test tube, nails, water, oil, matches and paper. Teacher writes the topic on the board. Teacher defines burning.

Stimulus Practice: Teacher tells students' that burning is an oxidation reaction. Teacher writes the effect of oxygen on burning and rusting. The teacher calls the process oxidation. Teacher writes burning, rusting, oxygen and oxidation on flash cards, Teacher arranges the flash cards on the chalkboard. Teacher defines oxidation.

Guided Practice: Students: (i) suggest the common things about rusting and burning and write them on flash cards.

(ii). List the differences between rusting and burning on flash cards.

(iii).Each group draws up plans on how to prevent rusting on flash cards.

(iv).Each group agrees on which procedure to follow

(v). Each group carries out a process to prevent metal from rusting.

Evaluation: Students ask questions for discussion. Teacher goes round to assess the suggestions on the flash cards. Teacher summarizes the different ways of preventing rusting from students' discussions.

Follow-up Activity: Each group of students finds out why cars are painted with different colours.

LESSON V

Topic: Energy

Time: 40 Minutes

Instructional Materials: Candle, matches, pieces of cardboard.

Behaviuoral Objectives: At the end of the lesson, students' should be able to:

(a) define energy

(b) list the sources of energy

(c) name forms of energy.

Previous Knowledge: Students' eat food and play, see cars moving.

Introduction: Teacher asks the students' to mention what they gain from the food they eat.

Presentation: Teacher puts students' into groups of 5 each. Teacher supplies each group with matches and candle. Teacher supplies flash cards to students'. Teacher writes the topic on the chalkboard. Teacher defines energy.

Stimulus Practice: Teacher writes candle, match, food and plants on flash cards and arranges them on the chalkboard.

Guided Practice: Students: (i) list some objects that can produce energy and suggest different forms of energy.

(ii) Write sources and different forms of energy on flash cards.

(iii) Select and arrange the flash cards with relevant sources and forms of energy.

(iv) Each group draws up plans on how to identify the forms of energy in a burning candle.

(v) Each group agrees on the most appropriate procedure.

(vi) Each group lights the candle and feels the flame.

(vii) Teacher makes corrections and discusses the ideas about forms of energy.

Evaluation: Students ask questions and were discussed. Teacher goes round each group to score the sources and forms of energy on the flash cards. Teacher makes a summary of the discussion on the board..

Follow-up Activity: Students' bring touch light to the next lesson.

LESSON VI

Topic: Light Energy

Time: 40 Minutes.

Instructional Materials: Torchlight, cardboard, plain mirror.

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

(a) identify rays of light

(b) sketch ray diagram

(c) define reflection

Previous Knowledge: Students' can:

(a) define energy

(b) state sources of energy

(c) list forms of energy

Introduction: Teacher asks students' to name four things that can produce light.

Presentation: Teacher groups students' into 5 each. Teacher supplies each group with mirror and flash cards. Teacher writes the topic on the chalkboard and defines a ray of light.

Stimulus Practice: Teacher (i) writes incidence ray, normal ray and reflected ray on flash cards and arrange them on the chalkboard.

(ii) defines incidence ray, normal ray and reflected ray.

Guided Practice: Students':

(i) list the materials necessary for light to be reflected on flash cards.

(ii) select and arrange the flash cards with relevant materials.

(iii) each group draws up plans on how to cause light to be reflected from an object.

(iii) each group agrees on what to be done to demonstrate light reflection.

(iv) switch on the torchlight and direct the light onto the shining surface of the plain mirror. Students' state and draw:

(a) the path of the rays to the mirror on flash cards

(b) the path of light rays away from the mirror on the flash cards.

Evaluation: Teacher: (i) goes round to score light rays drawn on flash cards by each group.

(ii) a student from two groups sketch incidence ray and reflected ray on the chalkboard.

(iii)Students discuss the sketch and the teacher writes the summary on the board.

Follow-up Activity: Students' place two plain mirrors at an angle of 90^0 to each other and place a small object in front of the mirrors. The students' count and record the number of images in the two mirrors.

LESSON VII

Topic: Simple Machine

Time: 40 Minutes

Instructional Materials: Ruler, rectangular block, stone, thread.

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

(a) define a machine

(b) state the components of a simple machine

(c) classify levers.

Previous Knowledge: Students' have:

(a). broom at home

(b). knife at home

(c). seen a wheelbarrow before.

Introduction: Teacher asks students' to name four things they use to do any kind of work at home.

Presentation: Teacher groups students' into 5 each. Teacher supplies each group with flash cards, ruler, rectangular block, stone and thread. Teacher writes the topic on the chalkboard and defines a simple machine.

Stimulus Practice: Teacher (i) writes the components of a lever on flash cards and arrange them on the chalkboard.

(ii) sketch the arrangement of the parts of a typical lever.

Guided Practice: Students':

(i) list different machines used at home on flash cards.

(ii) select and classify them into the classes of levers in the flash cards.

(iii) each group draws up plans on how to arrange the materials supplied to illustrate a lever.

(iv) each group agrees on the arrangement from first, second to third classes of lever.

(v) Arrange the materials in the order and draw each arrangement on flash cards

Evaluation: Teacher: (i) goes round to score sketch of the classes of levers drawn on flash cards by each group.

(ii) a student from three groups sketch a class of lever each on the chalkboard.

(iii) Students discuss the sketch and the teacher writes the summary on the board.

Follow-up Activity: Students' use broom to sweep and state what the dirt, broom and the hand resemble in a lever.

LESSON VIII

Topic: Simple Machine

Time: 40 Minutes

Instructional Materials: Pulley, rectangular block, stone, thread.

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

(a) define a pulley

(b) calculate Mechanical Advantage

Previous Knowledge: Students' use:

(a) broom at home for sweeping

(b) knife for cutting

(c) a wheelbarrow before for carrying materials.

Introduction: Teacher asks students' to name the three classes of lever with an example each.

Presentation: Teacher groups students' into 5 each. Teacher supplies each group with flash cards, pulley, stone and thread. Teacher writes the topic on the chalkboard and describes a pulley.

Stimulus Practice: Teacher (i) writes pulley, force and mechanical advantage on flash cards and arranges them on the chalkboard.

(ii) states the force ratio as mechanical advantage.

Guided Practice: Students':

(i) suggest materials needed for a pulley to function on flash cards.

(ii) select and arrange the flash cards with relevant materials.

(iii) each group draws up plans on how to arrange the materials for the machine to function.

(iv) each group agrees on step to follow in order to demonstrate how the machine can carry a load.

(iv) each group arranges the materials and pulls the thread passes through the pulley.

(v) state the formula for mechanical advantage

Evaluation: Teacher: (i) goes round to score a drawn and labeled arrangement of a functioning pulley on flash cards by each group.

(i) a student from two groups sketch a functioning pulley on the chalkboard.

(ii) Students discuss the sketch and the teacher writes the summary on the board.

Follow-up Activity: Students' solve a simple problem using the formula for mechanical advantage.

LESSON IX

Topic: Inclined plane

Time: 40 Minutes

Instructional Materials: Ruler, rectangular block, screw.

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

(a) describe an inclined plane

(b) identify parts of human body that work like levers

Previous Knowledge: Students' have seen:

1. people pushed drum into a lorry before
2. a screw tied to parts of the appliances at home.

Introduction: Teacher asks students' to (i) define mechanical advantage and (ii) state when a machine produces a mechanical disadvantage.

Presentation: Teacher groups students' into 5 each. Teacher supplies each group with flash cards, ruler, stone, rectangular block and screw.. Teacher writes the topic on the chalkboard and describes an inclined plane.

Stimulus Practice: Teacher (i) writes inclined plane, force, slope, effort and push on flash cards and arrange them on the chalkboard.

(ii) give examples of inclined plane.

Guided Practice: Students':

(i) list the parts of the forelimb on flash cards.

(ii) select and arrange the flash cards most functioning for the forelimb to bend.

(iii) each group draws up activities of the forelimb when used to pick object from the floor.

(iv) each group agrees to demonstrate picking an object from the floor and observe the forelimb.

(v) each group classifies the parts of the forelimb that resemble the parts of a lever on the flash cards

Evaluation: Teacher: (i) goes round to score classification on the flash cards by each group.

(ii) a student from three groups identifies a part of the forelimb each that resemble the parts of the lever on the chalkboard.

(iii) Students discuss the identities on the board and the teacher writes the summary on the board.

Follow-up Activity: Students' state what connects (i) bones to muscle and (ii) bone to bone.

APPENDIX III

COGNITIVE COACHING STRATEGY (EXPERIMENTAL GROUP 2)

LESSON I

Topic: Habitat

Time: 40 Minutes

Instructional Materials: Science text, Charts of habitats.

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

(a) define habitat

(b) list the kinds of habitats.

Previous Knowledge: Students' can identify:

(a) living things

(b) non-living things

Introduction: Teacher writes the topic on the board and asks the students' to:

(a) think of and mention things around them.

(b) name two living and non-living things.

Presentation: Teacher: (i) creates rapport on the students' responses and tells students' to form groups of 5 each.

(ii) shows them a chart of habitats.

(iii) tells the students' to study the chart carefully.

Stimulus Practice: Teacher: (i) calls students' to name two animals and two plants in the chart.

(ii) writes the definition of habitat on the chalkboard.

(iii) requests students' to read a passage on habitat from a science text.

Guided Practice: Each group of students': studies the text and picks things common and things not common to the two types of habitats. Students' write the main kinds of habitats in their workbook. Each group requests for a chart, studies and writes out the peculiarities of each habitat.

Evaluation: Teacher tells students' to swap their workbook and makes corrections on the chalkboard. Teacher tells students' to score. Students' raise questions and the teacher leads students' to discuss their ideas.

Follow-up Activity: Students' draw and label a biotic factor and an abiotic factor in an aquatic habitat.

LESSON II

Topic: Biotic and Abiotic factors

Time: 40 Minutes

Instructional Materials: Charts, aquarium.

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

(a) mention 4 biotic factors

(b) name 4 abiotic factors

(c) count the number of living things in a habitat.

Previous Knowledge: Students' can give:

(a) the meaning of habitat

(b) the kinds of habitat.

Introduction: Teacher: writes the topic on the board and instructs students' to think and name the living factors and non-living factors in:

(i) terrestrial habitat

(ii) aquatic habitat.

Presentation: Teacher: creates rapport on the students' responses and makes students' to form groups of 5 each. Teacher shows the students' the chart of the habitats and aquarium. Teacher instructs the students' to study the chart and observe the aquarium carefully.

Stimulus Practice: Teacher: (i) calls students' to name 2 animals and 2 plants from the two habitats.

(ii) defines biotic factor and abiotic factor and write the definition on the board.

(iii) requests students to read a passage on biotic and abiotic factors from science text.

Guided Practice: Each group: reads the text; writes the major differences between the two habitats in their workbook; studies the chart, observes the aquarium and counts the number of (i) biotic factors and (ii) abiotic factors.

Evaluation: Teacher instructs students' to swap works; makes corrections on the board and guides students' to score. Teacher raises questions and leads students' in a discussion.

Follow-up Activity: Students' count the number of a named flower on the school compound.

LESSON III

Topic: Rusting

Time: 40 Minutes

Instructional Objectives: Nails (rusted and rust-free), water, oil.

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

(a) define rusting

(b) state the conditions for rusting.

Previous Knowledge: Students' can name different non-living things, work with different metals and use water domestically.

Introduction: Teacher writes the topic on the board and instructs students' to:

(i) think and mention 3 different metals

(ii) mention what makes nails change nature.

Presentation: Teacher creates rapport on students' responses and tells them to form groups of 5 each. Teacher supplies students' with rusted and rust-free nails. Students' observe the nails carefully.

Stimulus Practice: Teacher: (i) calls the students' to mention two things that can cause the nails to change nature.

(ii) writes the meaning of rusting on the chalkboard and tells students' to read a passage on rusting from a science text.

Guided Practice: Each group: reads the text and picks 2 things that can cause nails to change nature (rust); writes down the identified causes of rusting in their workbook; studies the nails and compare with the ideas in the text; writes the conditions for rusting in their workbook.

Evaluation: Teacher tells students' to swap work, makes corrections and tells them to score. Students' raise questions, and teacher leads students' in discussion on the corrections.

Follow-up Activity: Students' put a new nail inside cup containing water for 5 days and write down what they can see.

LESSON IV

Topic: Rusting and Burning

Time: 40 Minutes.

Instructional Materials: Test tube, nails, water, paper, matches.

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

(a) compare rusting and burning

(b) state how rusting can be prevented.

Previous Knowledge: Students' can:

(a) define rusting

(b) state the conditions for rusting

Introduction: Teacher writes the topic on the board and instructs students' to:

(i) think and name 3 things that can burn.

(ii) state what will happen when we cover a pot of oil that catches fire.

Presentation: Teacher creates rapport on students' responses and tells students to form groups of 5 each. Teacher tells students' to light the paper to burn it and observe the rusted nails.

Stimulus Practice: Teacher:

(i) calls students' to name one thing responsible for burning and rusting.

(ii) writes the students' answers on the chalkboard.

(iii) defines burning.

(iv) requests students' to read a passage on how to prevent rusting.

Guided Practice: Each group: reads the text and pick out the common things about rusting and burning; writes the common things in their workbook; studies the rusted nails, the burnt paper compare with the text information and write the differences between rusting and burning in their workbook. Students write different means of protecting metals from rusting in their workbook.

Evaluation: Students' swap work and the teacher makes corrections and tells them to score. Students' raise questions and teacher leads students' in discussion.

Follow-up Activity: Students' paint a milk-tin with black paint.

LESSON V

Topic: Energy

Time: 40 Minutes

Instructional Objectives: Candle, matches, pieces of cardboard.

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

(a) define energy

(b) list the sources of energy

(c) name forms of energy.

Previous Knowledge: Students' play football, run around, use touch light.

Introduction: Teacher writes the topic on the board and instructs students' to:

(i) think and mention 3 things that can make things hot

(ii) mention 3 things that can produce light.

Presentation: Teacher creates rapport on students' responses and makes the students' to form groups of 5 each. Teacher supplies students' with matches and candle and tells each group to light the candle and feel the flame.

Stimulus Practice: Teacher: (i) calls students' to state what they feel with the burning candle by moving their hands close to it.

(ii) leads students' to define energy.

(iii) requests students' to read a passage on energy from a science text.

Guided Practice: Each group: reads the text and pick out sources of energy; observes and feels the burning candle again and studies the text to write out the forms of energy in their workbook.

Evaluation: Students' swap workbook, teacher makes corrections and tells them to score. Teacher leads students' to discuss the students' questions.

Follow-up activity: Students' bring torchlight to the next class.

LESSON VI

Topic: Light Energy

Time: 40 Minutes

Instructional Materials: Torchlight, cardboard, plain mirror.

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

(a) identify rays of light

(b) draw ray diagram

(c) define reflection.

Previous Knowledge: Students' can:

(a) define energy

(b) state sources of energy

(c) list forms of energy.

Introduction: Teacher writes the topic on the board and instructs students' to:

(a) think and mention 3 different kinds of energy.

(b) define energy.

Presentation: Teacher creates rapport on students responses and groups students' into 5 each. Teacher supplies them with torchlight, and plain mirror.

Stimulus Practice: Teacher(i) calls students' to describe what their eyes see at night if a small candle flame is observed for about 30 seconds.

(ii) defines light ray.

(iii) requests students' to read a passage on light reflection from a science text.

Guided Practice: Students' in each group: read the text and pick out the various light rays in the text; write the rays in their workbook; stand the plain mirror and direct light from the torchlight at a bent side; observe what happens; study the passage again and write the rays formed between the plain mirror and torchlight in their workbook.

Evaluation: Students' swap work. Teacher leads students in discussion on the corrections and instructs them to mark.

Follow-up Activity: Students' arrange two plain mirrors at angle 90^0 and place a small stone in front. Students' count the number of images in the mirror individually.

LESSON VII

Topic: Simple Machine

Time: 40 Minutes

Instructional Materials: Ruler, rectangular block, stone, thread.

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

(a) define a machine

(b) state the components of a simple machine

(c) classify levers.

Previous Knowledge: Students' have:

(a) broom at home

(b) knife at home

(c) seen a wheelbarrow before.

Introduction: Teacher writes the topic on the board and instructs students' to:

(a) think and mention 3 different kinds machines at home.

(b) state what a pair of scissors is used for.

Presentation: Teacher creates rapport on students responses and groups students' into 5 each. Teacher supplies them with ruler, rectangular block, stone and a thread.

Stimulus Practice: Teacher(i) tells students' to (i) place the rectangular block on the table and rest the ruler on it.

(ii) tie the thread to the stone and hang it on the ruler

Guided Practice: Students' in each group: read the text and pick out the meaning of a machine; arrange the parts of a lever; observe what happens; study the passage again and write the classes of lever in their workbook.

Evaluation: Students' swap work. Teacher leads students in discussion on the corrections and instructs them to mark.

Follow-up Activity: Students' give three examples each of the classes of lever.

LESSON VIII

Topic: Simple Machine

Time: 40 Minutes

Instructional Materials: Pulley, rectangular block, stone, thread.

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

(a) define a pulley

(b) calculate Mechanical Advantage

Previous Knowledge: Students' use:

(a) broom at home to sweep

(b) knife for cutting

(c) a wheelbarrow before for carrying materials.

Introduction: Teacher writes the topic on the board and instructs students' to:

(a) think and mention 3 classes of lever.

(b) state the class which a pair of scissors belongs with reason.

Presentation: Teacher creates rapport on students responses and groups students' into 5 each. Teacher supplies them with pulley, rectangular block, stone and a thread.

Stimulus Practice: Teacher tells students' to (i) hang the pulley on a retort stand and pass a thread through is groove.

(ii). tie one end of the thread to the rectangular block

(iii) pull the other end of the thread gently.

Guided Practice: Students' in each group: read the text and pick out the meaning of a pulley; state the effect of lever on force and state the formula for calculating mechanical advantage in their workbook

Evaluation: Students' swap work. Teacher leads students in discussion on the corrections and instructs them to mark.

Follow-up Activity: Students' work out a simple problem on mechanical advantage.

LESSON IX

Topic: Inclined plane

Time: 40 Minutes

Instructional Materials: Ruler, rectangular block, screw.

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

(a) describe an inclined plane

(b) identify parts of human body that work like levers

Previous Knowledge: Students' have seen:

(a) people pushed drum into a lorry before

(b) a screw tied to parts of the appliances at home.

Introduction: Teacher writes the topic on the board and instructs students' to:

(a) think and state the meaning of mechanical advantage.

(b) State when a machine is said to have a mechanical disadvantage

Presentation: Teacher creates rapport on students responses and groups students' into 5 each. Teacher supplies them with ruler, rectangular block, stone, a thread and screw.

Stimulus Practice: Teacher tells students' to (i) place one end of the ruler on the block.

(ii). Push a small stone through the ruler gently.

Guided Practice: Students' in each group: read the text and pick out the idea about an inclined plane; use their forelimb to pick a book up from the floor and observe the movement of the hand; state the parts of the forelimb that resemble the three parts of lever in their workbook

Evaluation: Students' swap work. Teacher leads students in discussion on the corrections and instructs them to mark.

Follow-up Activity: Students' state what connects (i) bone to muscles (ii) bone to bone.

APPENDIX IV

MODIFIED CONVENTIONAL METHOD (CONTROL GROUP)

LESSON I

Topic: Habitat

Time: 40 Minutes

Instructional Materials: Charts of habitats

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

(i) defines habitat

(ii) list the kinds of habitats.

Previous Knowledge: Students' can name different:

(i) living things

(ii) non-living things

Introduction: Teacher writes the topic on the board and asks the students' to:

(i) mention two places where fish can be found

(ii) name two plants found on land.

Presentation: The teacher connects new topic with previous lesson. The teacher hangs the chart on the wall for students' to observe.

Stimulus Practice: Teacher:

(i) defines habitat

(ii) lists the kinds of habitats

(iii) points at the biotic factors in aquatic habitat on the chart.

(iv) Points at the abiotic factors in terrestrial habitat on the chart.

(v) Describes each habitat using the charts.

(vi) Writes summary on the board and asks questions.

Guided Practice: The students': copy the chalkboard summary in their note book and respond to teacher's questions.

Evaluation: Teacher goes round to see students' copy the note. Teacher asks students' to:

(i) define habitat

(ii) state 2 kinds of habitats.

Teacher reinforces students' responses.

Follow-up Activity: Teacher gives assignment to students' to name 2 biotic factors.

LESSON II

Topic: Biotic and Abiotic factors

Time: 40 Minutes

Instructional Material: Charts of habitats

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

(i) mention 4 biotic factors

(ii) name 4 abiotic factors

(iii) count the number of living things in a habitat.

Previous Knowledge: Students' can give:

(i) the meaning of habitat

(ii) the kinds of habitats.

Introduction: The teacher writes the topic on the board and asks the students' to :

(i) define habitats

(ii) state the kinds of habitats

Presentation: Teacher connects new topic with previous lesson. Teacher hangs the chart on the wall for students to observe.

Stimulus Practice: Teacher: (i) names 4 living things and 4 non-living things each in aquatic and terrestrial habitats.

(ii) demonstrates counting the number of biotic factors from the chart in aquatic and terrestrial habitats.

(iii) writes chalkboard summary and asks questions.

Guided Practice: Students': watch teacher as he/she counts the biotic and the abiotic factors from the chart. Students listen to the teacher. Students' copy the chalkboard summary in their notebook and respond to teacher's questions.

Evaluation: Teacher moves round to see that all students copy the note. Teacher asks students' to:

(a). name 4 biotic factors in aquatic habitat.

(b). Name 4 abiotic factors in terrestrial habitat.

Teacher reinforces students' responses.

Follow-up Activity: Teacher gives assignment to students' to count the number of mango plants on the school premises.

LESSON III

Topic: Rusting

Time: 40 Minutes

Instructional Materials: rusted nails and rust-free nails.

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

(i) define rusting

(ii) state the conditions for rusting.

Previous Knowledge: Students' can identify various non-living things, use different metals for work and water domestically.

Introduction: The teacher writes the topic on the board and asks students' to mention 2 non-living things at home.

Presentation: Teacher connects new topic with previous lesson. Teacher shows the rusted nails to the students' and tells them that the cause of the change in nature is due to rusting.

Stimulus Practice: Teacher (i) defines rusting.

(ii) states what makes rusting possible on metals.

(iii) describes the reaction responsible for rusting.

(iv) writes the summary on the chalkboard and asks questions.

Guided Practice: Students': listen to teacher and observe the nails. Students' copy note down in their notebook and answer teacher's questions.

Evaluation: Teacher checks round to see that students' copy note. Teacher asks students' to:

(a). define rusting

(b). give 2 conditions for rusting.

Teacher reinforces students' responses.

Follow-up Activity: Teacher gives assignment: students' to bring a tin to the next class.

LESSON IV

Topic: Rusting and Burning

Time: 40 Minutes

Instructional Materials: Tin, oil, paper, matches.

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

(i) compare rusting and burning

(ii) state how rusting can be prevented.

Previous Knowledge: Students' can:

(i) define rusting

(ii) state the conditions for rusting

Introduction: Teacher writes the topic on the board and asks students' to:

a. define rusting

b. mention 2 substances necessary for rusting of metals.

Presentation: Teacher connects new topic with previous lesson. Teacher shows paper and matches to students'.

Stimulus Practice: Teacher: (i) burns paper and defines burning.

(ii) states that oxygen is necessary for paper to burn.

(iii) relates rusting with oxygen.

(iv) describes oxidation reaction as common to rusting and burning and states the differences between rusting and burning.

(v) states the methods of preventing rusting.

(vi) writes the summary on the chalkboard and asks questions.

Guided Practice: Students': watch the paper burning, listen to explanation and copy chalkboard summary in their notebook and respond to teacher's questions.

Evaluation: Teacher goes round to ensure that students' copy their note and asks students' to:

(a). state what makes burning and rusting to occur.

(b). mention 3 ways of preventing rusting.

Teacher reinforces students' responses.

Follow-up Activity: Teacher gives assignment to students' to cover the wall of a tin with grease.

LESSON V

Topic: Energy

Time: 40 Minutes

Instructional Materials: Candle, matches.

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

(i) define energy

(ii) list the sources of energy

(iii) name forms of energy.

Previous Knowledge: Students' do:

(i) eat food and play

(ii) see cars moving

Introduction: Teacher writes the topic on the board and asks the students' to give a reason why they eat food.

Presentation: Teacher connects new topic with previous lesson. Teacher lights the candle and tells students' to watch.

Stimulus Practice: Teacher states and writes:

(i) the meaning of energy

(ii) the sources of energy

(iii) the forms of energy on the board and asks questions.

Guided Practice: Students': copy note in their book and respond to teacher's questions.

Evaluation: Teacher goes round to ensure that students' copy the note and asks students' to:

(i) define energy

(ii) state 3 sources of energy

(iii) name 2 forms of energy produced by the burning candle.

Teacher reinforces students' responses.

Follow-up Activity: Teacher gives assignment to students' to list 3 other forms of energy.

LESSON VI

Topic: Light Energy

Time: 40 Minutes

Instructional Material: A chart showing ray diagrams.

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

(i) identify light rays

(ii) draw ray diagram

(iii) define reflection.

Previous Knowledge: Students' can:

(i) define energy

(ii) state sources of energy

(iii) list forms of energy

Introduction: Teacher writes the topic on the board and tells students' to mention four things that can produce light.

Presentation: Teacher connects new topic with previous lesson. Teacher hangs the ray diagram chart on the chalkboard.

Stimulus Practice: Teacher: (i) touches and mentions the rays on the chart.

i. defines normal ray, incidence ray, reflected ray and reflection.

ii. writes the summary on the chalkboard and asks questions.

Guided Practice: Students': watch the teacher; copy the chalkboard summary in their notebook; draw light rays from chart and answer teacher's questions.

Evaluation: Teacher moves round to monitor students to copy note and asks students' to:

(a) name the 3 possible light rays

(b) define reflection.

Teacher reinforces students' responses.

Follow-up Activity: Teacher gives assignment to students' to draw ray diagram.

LESSON VII

Topic: Simple Machine

Time: 40 Minutes

Instructional Material: A chart showing simple machine diagrams.

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

(a) define simple machine

(b) state the components of a simple machine

(c) classify levers.

Previous Knowledge: Students' have:

(a) broom at home

(b) knife at home

(c) seen a wheelbarrow before.

Introduction: Teacher writes the topic on the board and tells students' to mention four things used at home to help them do some works.

Presentation: Teacher connects new topic with previous lesson. Teacher hangs the chat of simple machine on the chalkboard.

Stimulus Practice: Teacher: (i) touches and mentions the parts of a lever on the chart.

(ii) defines a lever and classifies lever into first, second and third classes

(iii) writes the summary on the chalkboard and asks questions.

Guided Practice: Students': watch the teacher; copy the chalkboard summary in their notebook; draw a sketch of a lever from chart and answer teacher's questions.

Evaluation: Teacher moves round to monitor students to copy note and asks students' to:

(a) name the 3 classes of lever

(b) define simple machine.

Teacher reinforces students' responses.

Follow-up Activity: Teacher gives assignment to students' to name five simple machines and classify them into classes of lever

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LESSON VIII

Topic: Simple Machine

Time: 40 Minutes

Instructional Material: A chart showing simple machine diagrams.

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

(a) define a pulley

(b) calculate Mechanical Advantage

Previous Knowledge: Students' use:

(a) broom at home for sweeping

(b) knife for cutting

(c) a wheelbarrow before for carrying materials.

Introduction: Teacher writes the topic on the board and tells students' to mention the three classes of lever with an example each.

Presentation: Teacher connects new topic with previous lesson. Teacher hangs the chat of simple machine on the chalkboard.

Stimulus Practice: Teacher: (i) touches and mentions the parts of a pulley on the chart; defines a pulley and how it can be used to lift a load.

a. Explains how mechanical advantage can be calculated and states the formula.

b. writes the summary on the chalkboard and asks questions.

Guided Practice: Students': watch the teacher; copy the chalkboard summary in their notebook; draw a sketch of an inclined plane and a screw from chart and answer teacher's questions.

Evaluation: Teacher moves round to monitor students to copy note and asks students' to:

(a) define a pulley.

(b) state the formula for calculating mechanical advantage.

Teacher reinforces students' responses.

Follow-up Activity: Teacher gives assignment to students' to calculate the mechanical advantage of a knife used to peel a yam 3N with an effort of 2N by a woman.

LESSON IX

Topic: Inclined plane

Time: 40 Minutes

Instructional Material: A chart showing inclined plane diagram, a screw and human arm .

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

(a) describe an inclined plane

(b) identify parts of human body that work like levers

Previous Knowledge: Students' have seen:

(i) people pushed drum into a lorry before

(ii) a screw tied to parts of the appliances at home.

Introduction: Teacher writes the topic on the board and tells students' to state the meaning of: effort, load and fulcrum.

Presentation: Teacher connects new topic with previous lesson. Teacher hangs the chat of inclined plane and parts of human arm showing bicep and triceps muscles on the chalkboard.

Stimulus Practice: Teacher: (i) touches and mentions the parts of an inclined on the chart.

i. describes an inclined plane and explains how the forelimb resemble a lever when picking an object from the floor.

ii. writes the summary on the chalkboard and asks questions.

Guided Practice: Students': watch and listen to the teacher's explanations; copy the chalkboard summary in their notebook; draw a sketch of an inclined plane from chart and answer teacher's questions.

Evaluation: Teacher moves round to monitor students to copy note and asks students':

(a) to describe an inclined plane.

(b) which part of the arm resembles: (i) a fulcrum, (ii) an effort and (iii) a load as in a lever?

Teacher reinforces students' responses.

Follow-up Activity: Teacher gives assignment to students' to name what connects (i) bone to muscle and (ii) bone to bone.

APPENDIX V

BASIC SCIENCE CONCEPTS ACHIEVEMENT TEST (BSCAT)

NAME OF SCHOOL……………………………………………………

NAME OF STUDENT…………………………………………………..

Age: ☐ Class: ☐

INSTRUCTION: This is a multiple choice test. Each question is followed by four options lettered "a" to "d". Find out the correct option for each question and circle. Choose only one answer to each question.

1. Rusting is caused on metals when

   (A) oxygen and oil are present (B) oxygen and water are present

   (C) water and oil are present (D) oxygen and substance are present

2. The energy that makes a boy to run is

   (A) potential energy (B) heat energy (C) kinetic energy (D) chemical energy

3. Bread contains

   (A) chemical energy (B) heat energy (C) potential energy (D) useful energy

4. Which of the following allows light energy to pass through it?

   (A) mirror (B) louver (C) plastic (D) maltina bottle.

5. Tilapia fish is found in

   (A) stagnant water (B) aquarium (C) fresh water (D) salt water

6. A mechanic can use a spinner to loose a bolt easily because the bolt has

(A) wedge (B) pitch (C) screw (D) rod

7. A 5kg bag of rice requires a force of 30N to carry it in a wheelbarrow, what is the mechanical advantage? (g = $10m/s^2$)

(A) 1.67 (B) 80 (C) 20 (D) 1500

8. Which of the processes below is very slow?

(A) rusting (B) burning (C) drinking (D) cooking

9. Which of the following is found in Abuja?

(A) desert (B) lagoon (C) savanna (D) forest

10. Aquarium contains the following except

(A) stones (B) tadpoles (C) snails (D) termite

11. Habitat is a place where organism

(A) play (B) eat (C) live (D) hide.

12. Chemical energy can be changed into

(A) food (B) light (C) sound (D) wood

13. When levers are used to do work, they help to

(A) divide force (B) add force (C) multiply force (D) subtract force

14. A lever is a simple machine with all of the following except

(A) screw (B) load (C) fulcrum (D) effort.

15. Burning candle produces

(A) light and heat energy (B) heat and flame energy

(C) light and melting energy (D) weak and small energy

16. A machine that has the load centrally placed is a

(A) first class lever (B) second class lever (C) third class lever

(D) none-class lever

17. Iron is a very useful

(A) nail (B) metal (C) rod (D) material

18. One of the following can play the role of a fulcrum of a simple machine in human body

(A) neck (B) joints (C) muscles (D) bones

19. Which one of the following is a terrestrial habitat?

(A) savanna (B) swamp (C) pond (D) lagoon

20. One thing common to rusting and burning is that

(A) water must be present (B) oxygen must be present

(C) occurs anytime (D) both produce bad things

21. Which of the following cannot produce light by itself

(A) sun (B) star (C) moon (D) lantern

22. A group of toads at the side of a pond is called a

(A) density (B) population (C) community (D) biotic factor

23. The ray at right angle to the surface of a plain mirror is called

(A) normal (B) incidence (C) reflected (D) lantern

24. A device with a small wheel called pulley has a

(A) thread along its rim (B) load hang on it

(C) means of turning in one direction only (D) groove along its rim

25. Iron decay in Nigeria causes Federal Government to waste

(A) petrol (B) energy (C) money (D) food

26. Burning changes woods

(A) physically (B) biologically (C) chemically (D) naturally

27. What is the population density of 20 cockroaches in a cupboard of $200cm^2$?

(A) $0.1/cm^2$ (B) $10\ cm^2$ (C) $4000\ cm^2$ (D) $180/cm^2$

28. Cutlass decay by undergoing

(A) physical change (B) natural change (C) chemical change

(D) common change

29 Which type of energy is produced when the two palms rub fast against each other?

(A) mechanical (B) force (C) heat (D) kinetic

30. When a nail changes colour to brown it is due to the formation of

(A) iron (III) oxide (B) iron (II) oxide (C) iron (I) oxide

(D) iron (IV) oxide .

APPENDIX VI (a)

BASIC SCIENCE CONCEPTUAL CHANGE DEBRIFING PROTOCOL (BSCCDP)

Concept	Task	Whole	Partial	Opposite	No Response
Habitat	1. With the aid of the chart describe aquatic habitat. 2. Use the chart provided to identify and show me (a) 2 biotic factors in aquatic habitat (b) 2 abiotic factors in terrestrial habitat. 3. Explain population 4. What steps will you take to determine the population density of grasshoppers on the school field?				

Adapted Structured Debriefing Protocol (Trundle, Atwood & Christopher, 2004)

APPENDIX VI (b)

BASIC SCIENCE CONCEPTUAL CHANGE DEBRIFING PROTOCOL (BSCCDP)

Concept	**Task**	**Whole**	**Partial**	**Opposite**	**No Response**
Rusting	1. Use the materials provided, describe the phenomenon shown by the object(s) 2. What are the factors/conditions responsible for the phenomenon? 3. Why is it necessary to prevent the phenomenon? 4. Light the candle provided. What differences are shown between the phenomenon and burning?				

Adapted Structured Debriefing Protocol (Trundle, Atwood & Christopher, 2004)

APPENDIX VI (c)

BASIC SCIENCE CONCEPTUAL CHANGE DEBRIFING PROTOCOL (BSCCDP)

Concept	Task	Whole	Partial	Opposite	No Response
Energy	1. You left your class for this debriefing, what enables you to do that? 2. Examine the coarse louver glass which is said to be translucent, why is it classified that way? 3. Switch on the torchlight provided and direct it to the shining surface of the plane mirror. What is happening? 4. You use certain object(s) to produce light for you to see at night, explain the type of energy conversion exhibited by the object(s).				

Adapted Structured Debriefing Protocol (Trundle, Atwood & Christopher, 2004)

APPENDIX VI (d)

BASIC SCIENCE CONCEPTUAL CHANGE DEBRIFING PROTOCOL (BSCCDP)

Concept	**Task**	**Whole**	**Partial**	**Opposite**	**No Response**
Simple Machine	1. Examine the setups A, B, C carefully, which class of lever is B? 2. Turn your head to the right and left. Why is it easier for you to do this? 3. To draw up water from a well, which simple machine will be better used? 4. A see-saw is an example of which class of lever?				

Adapted Structured Debriefing Protocol (Trundle, Atwood & Christopher, 2004)

APPENDIX VI (e)

ANSWERS TO BASIC SCIENCE CONCEPTUAL CHANGE DEBRIEFING PROTOCOL (BSCCDP)

HABITAT

(1) Aquatic habitat contains water

-contains living things like:

- animals and plants

-mud

(1) (a) – Fish/tadpole/mosquito larva

-Crab/snail/water lettuce/spirogyra

(b)- Water/light/soil/mud/stone/wood

(3) Population- total number of organisms

- of the same kind/species in a given area.

(4) – Locate the field

- obtain a quadrat of known area

- make many tosses

- count the number of grasshopper in each throw/toss.

- divide number of Grasshopper by the area.

RUSTING

(1) The object is decaying (rusting)

(2)- Oxygen must be present

- Water/moisture must be present

(3)- To avoid wastage of money

- To prevent damage to iron

- To make iron function adequately

- To make iron have long life

(4) – Burring occurs fast

- It produces flames

-Reduces the size of candle

ENERGY

(1) I have energy to do the walking

(2) It allows light to pass through it but man cannot see through it

(3) Yes

- Principle of reflection

(4) –Chemical to light

- Electrical to light

SIMPLE MACHINE

(1) A –

B is second class

(2) There is a pivot/fulcrum at the joint between the head/neck or skull and cervical vertebrae

(3) A wheel/Axle

(4) First class

APPENDIX VII

ATTITUDE TOWARDS BASIC SCIENCE SCALE (ATBSS)

INSTRUCTION: Fill in the information in section A. Read each statement in section B carefully and tick under the column to show your decision about the statements. Tick one of the options: Strongly Agree (SA), Agree (A), Disagree (D), or Strongly Disagree (SD). You are encouraged to choose an option in each case.

SECTION A

School--

Name of student---

Class-----------------------------------Age-----------------------------------

SECTION B

S/N	Item	Response			
		Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
1	I like to do Basic Science because we do work with materials in all the topics.				
2	Our Basic Science teacher is friendly in and out of lesson.				
3	We can prove our observations during Basic Science lessons.				

4	Studying natural processes makes Basic Science more interesting.				
5	Doing practical things in Basic Science improves my manipulative skills.				
6	Basic Science gives me the opportunity to work in the laboratory.				
7	Basic Science makes me to dispel superstitions.				
8	I hope to be a scientist in future.				
9	Everybody needs to apply scientific knowledge in everything a person does.				
10	Finding out things independently makes me to improve my understanding of scientific concepts.				
11	I find Basic Science class very boring.				
12	Our Basic Science teacher uses languages that I cannot understand.				
13	Studying Basic Science				

	consumes more time.				
14	I do not have enough time to play together with classmates in Basic Science class.				
15	Scientists do not believe in God.				
16	Some things look like magic in science.				
17	Basic Science is very difficult to understand.				
18	Basic Science makes me to go against my culture.				
19	Basic Science does not allow me to have time to rest.				
20	Basic Science practical makes us to waste many things.				

APPENDIX VIII

MENTAL ABILITY TEST (MAT)

SECTION A

NAME OF STUDENT…………………………………………………….

NAME OF SCHOOL……………………………………..………………..

Did you pass Basic Science last term? YES ☐ NO ☐

SECTION B

EXAMPLE A: Four of the following are alike in some way, write the other two in the bracket.

1. biro 2. crayon 3. milk 4. pencil 5. water 6. chalk. (3 & 5)

EXAMPLE B: Biro is to book as student is to

1. school 2. home 3. bus 4. assembly 5. match (1).

EXAMPLE C: Which two of the following statements mean the same?

(1) Ojo is a boy

(2) Ojo can play ball

(2) Ojo is the only son of his father

(4) Ojo is growing

(5) Ojo is a teenager (1 & 5).

Now answer the following questions. Think fast and do not waste time on any question. Try to answer as many as you can. (25 minutes)

Q1. Four of the following are alike in some way, write the numbers of the other two in the bracket.

1. goat 2. leg 3. eye 4. rabbit 5. ear 6. mouth ( ).

Q2. Which two of the following statements mean the same?

1. Houses can be of different designs
2. My father is to build a house
3. There are plenty houses in our town
4. We use soil and water materials to build houses
5. We build houses on land ( ).

Q3. Which two of the following statements mean the same?

1. There are four tires in the car
2. That car has many passenger
3. There is a driver in the car
4. The car must stop very soon
5. A car is moving with speed ( ).

Q4. Four of the following are alike in some way, write the numbers of the other two in the bracket.

1. carrot 2. yam 3. ginger 4. orange 5. onion 6. tomato ( ).

Q5. Rider is to bicycle as police is to

1. 20 Naira 2. arrest 3. check point 4. security 5. barrack. ( ).

Q6. Car is to road as helicopter is to

1. fly 2. land 3. air 4. pilot 5. travel ( ).

Q7. Which two of the following statements mean the same?

1. Boys put on caps in JSS II
2. JSII students possess caps
3. No students from other classes have caps
4. JSII monitor has many caps
5. All JS II students put on caps ( ).

Q8 Four of the following are alike in some way, write the numbers of the other two in the bracket.

1. tree 2. soil 3. root 4. fruit 5. sunlight 6. leaves ( ).

Q9. HIV/AIDS is to human being as Governor is to

1. teacher 2. president 3. politician 4. commissioner 5. police ( ).

Q10. Four of the following are alike in some way, write the numbers of the other two in the bracket.

1. wood 2. food 3. work 4. play 5. fire 6. energy ( ).

Q11. Mouth is to eat as table is to

1. student 2. office 3. dining 4. carpenter 5. chair ( ).

Q12. Root is to plant as eye is to

1. head 2. brain 3. body 4. see 5. sleep ( ).

Q13. Which two of the following statements mean the same?

1. Basic Science textbook is necessary for us to pass it
2. My father has not bought Basic Science textbook for me
3. My friend has three Basic Science textbooks
4. The state government provided Basic Science textbook for us
5. The questions in Basic Science textbook are not asked in exams ( ).

Q14. Which two of the following statements mean the same?

1. Everybody needs water
2. Water is good for the body
3. Water is a natural gift
4. Water is available everywhere
5. We drink water everyday ( ).

Q15. Four of the following are alike in some way, write the numbers of the other two in the bracket.

1. classroom 2. bicycle 3. church 4. car 5. hall 6. stadium ( ).

Q16. Four of the following are alike in some way, write the numbers of the other two in the bracket.

1. number 2. add 3. count 4. paper 5. write 6. read ( ).

Q17. Toothpaste is to the teeth as sound is to

1. radio 2. singers 3. music 4. ear 5. mouth ( ).

Q18. Handset is to dial as radio is to

1. battery 2. wire 3. plastic 4. cassette 5. news ( ).

Q19. Which two of the following statements mean the same?

1 I learn to know

2. The teacher taught me

3. I am always learning

4. I know because I learn

6. I am a learner ( )

Q20. Four of the following are alike in some way, write the numbers of the other two in the bracket.

1. cup 2. bottle 3. water 4. plate 5. jug 6. oil ( ).

Adapted Mental Ability Test (Bamidele, 2000)

APPENDIX IX

SELF-CONCEPT INVENTORY (SCI)

INSTRUCTION: Fill in the information in section A. Read each statement in section B carefully and tick under the column to show your decision about the statements. Tick one of the options only for each item.

SECTION A

NAME OF STUDENT--

SCHOOL---

CLASS--AGE----------------------------------

SECTION B

S/N	Item Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
1	I am afraid of people.				
2	I feel lonely all the time.				
3	I tell lie sometimes.				
4	I am shy.				
5	I do not talk as other students do.				
6	I come from poor family.				
7	My parents are separated.				
8	I do not have friends.				
9	I cannot think of new idea				
10	I am too weak.				
11	I am happy with myself.				

12	I can speak with everybody.				
13	I am very active in school				
14	I like everybody around me				
15	I like to work well.				
16	I want to know new things all the time.				
17	I can lead my friends to do anything.				
18	I read my books always.				
19	I like group work.				
20	Many students make friends with me.				

Adapted Self-Concept Inventory (Aremu, 1997)

APPENDIX X

SIMPLEX STRATEGY ASSESSMENT SHEET FOR EVALUATING TEACHER'S PERFORMANCE (SSASETP)

NAME OF TEACHER ---

QUALIFICATION---------------------------------TOPIC--

CLASS-------------------------------------DATE---

TIME---------------------------------------SCHOOL--

S/N	Feature	Score					
		5	**4**	**3**	**2**	**1**	**0**
1.	Introduction of concept.						
2.	Lesson development.						
3.	Mastery of subject matter.						
4.	Effective strategy implementation.						
5.	Skills displayed: (a) Asks relevant questions.						
	(b) Allows students' to select ideas.						
	(c) Allows students' to contribute facts/ideas.						
	(d) Defines the concept.						
	(e) Allows students' to carry out investigation.						
	(f) Discusses ideas clearly.						
6.	Evaluation: (a) Sustainability of assessment.						
	(b) Attainability of stated objective.						
7.	Grading follow-up activity						

Comments:…………………………………………………………………………

…………………………………………………………………………………

COGNITIVE COACHING STRATEGY ASSESSMENT SHEET FOR EVALUATING TEACHER'S PERFORMANCE (CCSASETP)

NAME OF TEACHER ---

QUALIFICATION---TOPIC---

CLASS---DATE---

TIME---SCHOOL---

S/N	Feature	Score					
		5	4	3	2	1	0
1.	Introduction of concept.						
2.	Lesson development.						
3.	Mastery of subject matter.						
4.	Effective strategy implementation.						
5.	Skills displayed: (a) Initiates verbal rapport.						
	(b) Prompts students' to express themselves freely.						
	(c) Allows students' to think and communicate ideas.						
	(d) Allows students to read and reflect on text.						
	(e) Allows students' to plan activity.						
	(f) Carry out investigation in reasonable time.						
6.	Evaluation: (a) Sustainability of assessment.						
	(b) Attainability of stated objective.						
7.	Grading follow-up activity						

Comments:………………………………………………………………………

………………………………………………………………………………

MODIFIED CONVENTIONAL METHOD ASSESSMENT SHEET FOR EVALUATING TEACHER'S PERFORMANCE (MLMASETP)

NAME OF TEACHER---

QUALIFICATION-----------------------------------TOPIC--

CLASS---DATE--

TIME--SCHOOL-----------------------------------

S/N	Feature	Score					
		5	4	3	2	1	0
1.	Introduction of concept.						
2.	Lesson development.						
3.	Mastery of subject matter.						
4.	Effective strategy implementation.						
5.	Skills displayed: (a) Use of chalkboard.						
	(b) Good questioning technique.						
	(c) Effective use of instructional resources.						
	(d) Reaction to and reinforcement of students' contribution.						
	(e) Appropriate use of language.						
6.	Evaluation: (a) Sustainability of assessment.						
	(b) Attainability of stated objective.						
7.	Grading follow-up activity						

Comments:……………………………………………………………………………

……………………………………………………………………………………

APPENDIX XIA
SUMMARY OF THE NIGERIAN INTEGRATED SCIENCE PROJECT CURRICULUM (NISP)

Unit	Year One Topics	Year Two Topics	Year Three Topics
You as a living thing	Living things Human beings as higher animals	The skeletal and muscular systems The digestive system The circulatory system The respiratory system The excretory system	The nervous system
You and your home	Reproduction Personal health A healthy environment	Physical growth and development Gardening and poultry keeping Continuity of life	Continuity of the family
Living things in the environment	Plants and animals	Habitats	Resources from living things Feeding in plants and animals
Non living things in the environment	States of matter Measuring things Air Water Man in space	Pure and impure substances Oxygen Hydrogen Water Rusting Energy measurement	Writing chemical equations Atomic structure Acids, bases and salts Metals and non-metals Energy conservation Energy transfer Man in space
Saving your energy	Tools for work Forces	Simple machines	Work and energy
Controlling the environment	Environmental sanitation Disease vectors Preventing diseases	Energy and materials for communities Balanced environment	Pollution Erosion and flooding Weather

Source: STAN Course Books JSS 1-3, (1982)

APPENDIX XIA
SUMMARY OF BASIC SCIENCE CURRICULUM

Theme	Year One Topics	Year Two Topics	Year Three Topics
You and environment	Family health Environmental conservation and safety I (maintaining balance) Environmental conservation and safety II (sanitation) Disease prevention Prevention of STDs, HIV/AIDS Drug abuse I The earth in space	Family health (Diseases) Environmental pollution: (i) Water (ii) Air (iii)Soil Drug abuse II	Family traits (Genetics) Environmental hazards: (i) Soil erosion (ii) Flooding (iii) Bush burning (iv) Deforestation (v) Desertification Depletion of ozone layer and its effects Drug abuse III
Living and non living things	Matter Living things Activities of living things Non living things	Living things: (i) Habitat (ii) Uniqueness of man Changes in matter Changes in living things Changes in non living things The human body: (i) Skeletal system and movement (ii) Respiratory system (iii) Circulatory	Metabolism in human body Sense organs Reproductive health Non living things Resources from living things Resources from non living things: (i) Soil (ii) Solid materials

		system (iv) Digestive system (v) Reproductive system (vi) Excretory system	
Science and development	Gravitational and weightlessness Space travel Satellite	Information and communication technology (ICT) Crude oil and petrochemicals	Skill acquisition Ethical issues in science and development
You and energy	Energy Renewable and non renewable energy Forces	Work, energy and power Simple machines (wheel and axle) Simple machines (screw thread) Simple machines (gears) Efficiency of simple machines Kinetic energy Thermal energy	Light energy Sound energy Magnetism Electrical energy Radioactivity

Source: NERDC Basic Science Curriculum 1-3, (2007)

APPENDIX XII

List of Schools involved in this Study

Pilot Study

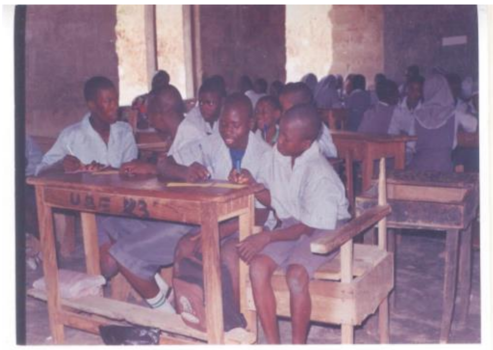
Local Government Area	School	Location	Group
Kontsgora	1. Baptist Comprehensive School 2. Model Secondary School	Kontagora Kontagora	Pilot

Main Study

Local Government Area	School	Location	Group
Ifelodun	1. Government Junior Secondary School 2. Ja'amat Nasirul Islam Secondary School	Bode Saadu Babanloma	Control
Kaiama	1. Unity School 2. Government Secondary School	Kaiama Kaiama	Cognitive Coaching
Moro	1. Government Junior Secondary School 2. United Missionary Church of Africa School	Jebba Jebba	Simplex strategy

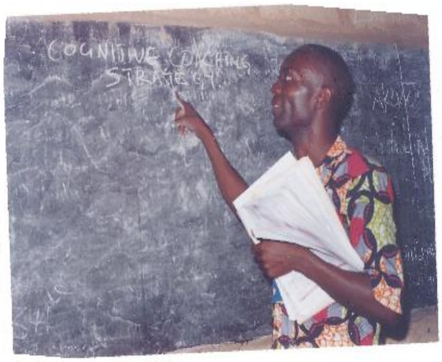
1.

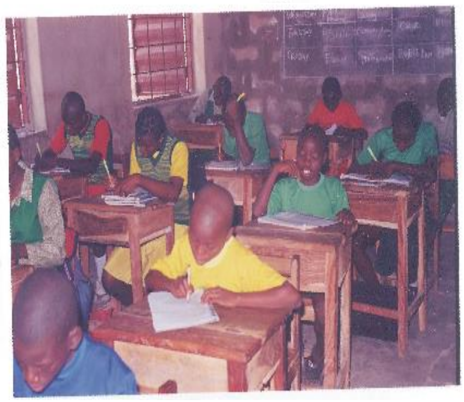
SIMPLEX GROUP



2.

COGNITIVE COACHING GROUP





3.

MODIFIED CONVENTIONAL METHOD GROUP