EFFECTS OF EXPERIENTIAL AND GENERATIVE LEARNING STRATEGIES ON STUDENTS' ACADEMIC ACHIEVEMENT, ATTITUDE TO AND PRACTICAL SKILLS IN BIOLOGY IN OYO STATE, NIGERIA

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CERTIFICATION

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DEDICATION

This research work is dedicated to: GOD ALMIGHTY, the source of my inspiration, strength and support.

The work is also dedicated to

Jide Awolere

Tinu Awolere

Tobi Awolere

and all other Awoleres.

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2. Otu Community Grammar School, Otu – Itesiwaju Local Government (ELS 2)
3. St. John's Catholic High School, Iseyin – Iseyin Local Government (ELS 3)
4. A.D.S. Grammar School, Okeho - Kajola Local Government (GLS 1)
5. Okaka Community Grammar School, Okaka - Itesiwaju Local Government (GLS 2)
6. Ekunle Grammar School, Iseyin - Iseyin Local Government (GLS 3)
7. Baptist High School, Ilero - Kajola Local Government (MCS 1)
8. Ipapo Community Grammar School, Ipapo- Itesiwaju Local Government (MCS 2)
9. Baptist Secondary Grammar School, Iseyin- Iseyin Local Government (MCS 3)

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ABSTRACT

Biology is a core science subject offered in Nigerian Senior Secondary Schools (SSS). However, students' achievement in the subject in Oyo State is not encouraging, a trend which probably is due to their poor attitude, low practical skills and teacher-centered teaching strategies. Scholars have thus indicated the need for the adoption of active learning instructional strategies to address this deficiency. Literature have documented the effectiveness of these strategies in enhancing students' learning outcomes in Physics and Chemistry but no such studies have been carried out on students' achievement in Biology. This study, therefore, determined the effects of Experiential Learning (ELS) and Generative Learning (GLS) Strategies on students' academic achievement, attitude to and practical skills in Biology in Oke-Ogun area of Oyo State. The moderating effects of gender and mental ability were also examined.

The study adopted pretest-posttest control group, quasi-experimental design with a 3x2x3 factorial matrix. Random sampling was used in selecting three Local Government Areas (LGAs) from Oke-Ogun area of Oyo State. Purposive sampling was used to select nine SSS across the LGAs while an intact class of Senior Secondary Students I was selected from each of the schools for a total of 428 participants. Participants were randomised to ELS, GLS and Control groups, while the treatment lasted 12 weeks. Seven instruments were used: Biology Achievement Test (r=0.74), Students Attitude to Biology Questionnaire (r=0.82), Biology Student Skills Rating Scale (r=0.74), Mental Ability Test (r=0.86) and Instructional guides on ELS (π=0.75), GLS (π=0.78) and control (π=0.76). Seven null hypotheses were tested at 0.05 level of significance. Data were subjected to analysis of covariance, multiple classification analysis and Scheffe post-hoc test.

Results showed that treatment had a significant main effect on students' achievement score ($F_{(2,410)}$=522.20, η^2= 0.07) and practical skills($F_{(2,410)}$=1299.30, η^2= 0.86) but not on attitude. Participants in ELS had highest achievement scores ($\bar{x}$=20.14), followed by those in GLS ($\bar{x}$=17.69) and control ($\bar{x}$=5.59). Also participants in ELS had the highest enhanced practical skills ($\bar{x}$=22.56) than those in GLS ($\bar{x}$=19.66) and control ($\bar{x}$=9.58). There was a significant main effect of mental ability on students' academic achievement in Biology ($F_{(2,410)}$ =5.6, η^2=0.22) but not on gender. Students with high mental ability had higher adjusted mean score ($\bar{x}$=17.55) than those with low mental ability ($\bar{x}$=13.60). The two-way interaction effects of treatment and mental ability on students' achievement, attitude to and practical skills was not significant. The two-way interaction effects of treatment and gender on students' achievement, attitude to and practical skills was not significant. The three-way interaction effect of treatment, gender and

mental ability on students' achievement, attitude to and practical skills was not significant.

The experiential and generative learning strategies enhanced students' achievement and practical skills in Biology in Oke-Ogun area of Oyo State. The two strategies should therefore be adopted in teaching Biology to senior secondary school students.

Keywords: Experiential learning strategy, Generative learning strategy, Achievement in biology Practical skills in biology, Attitude to biology.

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LIST OF ABBREVIATION

1	ACER	Autrailian Council for Educational Research
2	ANCOVA	Analysis of Covariance
3	BAT	Biology Achievement Test
4	BPSRS	Biology Practical Skills Rating Scale
5	ELS	Experiential Learning Strategy
6	EMM	Estimated Marginal Mean
7	ESAT	Evaluation Sheet for Assessing Teachers
8	FGN	Federal Government of Nigeria
9	FME	Federal Ministry of Education
10	FRN	Federal Republic of Nigeria
11	GLS	Generative Learning Strategy
12	IGELS	Instructional Guide on Experiential Learning Strategy
13	IGGLS	Instructional Guide on Generative Learning Strategy
14	IGMCS	Instructional Guide on Conventional Strategy
15	MAT	Mental Ability Test
16	MCA	Multiple Classification Analysis
17	MCS	Modified Conventional Strategy
18	NERDC	National Education Research and Development Council
19	NPE	National Policy on Education
20	NTI	National Teachers' Institute
21	OECD	Organisation for Economic Co-operative and Development
22	PISA	Programme for Internal Students Assessment
23	SAB	Questionnaire on Attitude to Biology
24	SSCE	Senior School Certificate Examination
25	UNESCO	United Nations Educational Scientific & Cultural Organisation
26	WAEC	West African Examination Council
27	WASSCE	West African Senior School Certificate Examination

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

Scientific literacy is a major gateway to achieving scientific and technological advancement and economic survival, (ACER, 2015; OECD, 2009, and UNESCO, 2008). One of the ways for achieving this scientific literacy is through science education. Science Education, specifically Science and Technology contribute immensely to educational development, as seen in teaching and learning process. Science Education also helps to improve the social, economic, political, and the entire lifestyle of mankind. According to Garba {2009, p. 49}, Science Education can be defined as "those aspects of education which leads to acquisition of practical and applied skills as well as basic scientific knowledge"

Scientific literacy relates to the ability to think scientifically and use scientific knowledge and processes to both understand the world around us and participate in decisions that affect it (Lee, 2001). Increasingly, science and technology shape our lives. Scientific literacy is considered to be a key outcome of education for all students at the end of schooling —not just for future scientists— given the growing centrality of science and technology in modern societies (Holt and Willard, 2000). The skill and ability to think scientifically about evidence and the absence of evidence for claims that are made in the media and elsewhere are vital to daily life (UNESCO, 2008, 2004).

A scientifically literate student is able to apply his/her knowledge of scientific concepts and processes to the evaluation of issues and problems that may arise, and to the decisions that he/she makes in his/her daily life, about the natural world and changes made to it through human activity. (Ogundiwin, 2013).

If science and technology will be sustained and promoted, then science education should be seen and taken as a major investment. Alebiosu {2003} asserted that "Science and Technology aim at the provision of the necessity of life so as to make life and living more comfortable". That is why students' attitude towards science has become a major concern of science education researchers as an attempt to increase attitude, performance and retention among students.

Science comprises basic disciplines such as Physics, Chemistry, Mathematics and Biology. Many studies revealed that students in secondary schools are not very interested in science (Sethi 2010; Alebiosu, 2007; Juuti, Lavonen, Uitto, Byman and Meisalo, 2004; Alebiosu 2003; Esiobu, 2000). Nowadays, Biology education has received special attention from educators and researchers, because of its relevance to other fields of study.

The National Policy on Education (FRN, 2013; 2009; 2007 and 2004) makes it compulsory for all students to offer at least a science subject at the senior secondary school in Nigeria in the old curriculum but the science subjects are no longer a requirement for senior secondary school students to offer as part of the core subjects (Abimbola, 2013) in the new curriculum. However, biology is the subject most preferred and chosen by many science students (Abubakar, 2001, Nwosu, 2006). This will go a long way to produce a scientifically literate society devoid of ignorance and diseases (Abimbola, 2013).

Biology is classified as one of the core subjects that should be offered by students at the senior secondary school during examinations (FGN, 2004). Biology occupies a unique position in the school curriculum and it is the most patronized subject among all the sciences. It is central to many science related courses such as medicine, pharmacy, agricultural science, nursing, biochemistry, microbiology and so on. It is obvious that no students intending to study these courses can do so without Biology, and a credit in Biology is a pre-requisite (Yusuf and Afolabi, 2010). Johnson (2006) pointed out that the importance of Biology will continue to have a profound impact on our lives for decades. He further stressed that Biological science stimulates human interest to find the truth with an intellectual rigor therefore its importance in culture and education cannot be overemphasized.

Federal Ministry of Education/ National Education Research and Development Council (2009) state the following objectives in its curriculum for Biology:

- Understanding of the structure and function of living organisms as well as appreciation of nature;
- Acquisition of adequate laboratory and field skills in order to carry out and evaluate experiments and projects in Biology;

- Acquisition of necessary scientific skills for example observing, classifying and interpreting biological data;
- Relevant knowledge in Biology needed for future advanced studies in biological science;
- Acquisition of scientific attitude for problem solving;
- Ability to apply biological principles in everyday life in matters that affect community health, personal, social, environmental, and economic problems.

The new 2009 edition of the Biology curriculum (NERDC, 2009) now has only four themes namely:

- Organization of life,
- The organism at work,
- The organism and its environment, including
- Continuity of life.

As important as knowledge of Biology is to human beings, it is disheartening that students' achievement in this subject at the secondary school level is becoming worse than in the other science subjects (Ibe and Maduabum, 2011;Chidolu, 2001). In the words of Oginni, (2009), he stated that "*despite the important place of biology to mankind and its central position in science generally, the learning outcomes of students in the subject are not encouraging".*

Agbonmian (2002); Ibe and Maduabum (2001) argued that candidates' performance at the Senior School Certificate Examinations (SSCE) conducted by West African Examination Council have consistently remain poor, with Biology having the highest enrolments and the poorest results over the years.

Due to the importance of Biology to the national development and its foundation for advanced professional courses in fields such as medicine, pharmacy, nursing and other allied courses and the state of poor academic achievement in the subject at the secondary school level; then, it should become a thing of serious concern to any citizen of Nigeria.

The West African Secondary Schools Certificate Examination (WASSCE) results over the years have shown that the performance of students has not been encouraging. Several other research reports indicate students' underachievement and poor performance in Biology (Olagunju, 2006). Ayanda (2006), while citing from

WAEC chief Examiners' reports maintained that students' performance in Biology was poor despite the fact that several crucial efforts have been made continually over the years to remedy the yearly poor performance and also improve students' performance.

An analysis of the WASSCE results shows a less than average credit pass performance throughout the years examined.

Table 1.1 Percentage Distribution of Students' Performance in May/June Senior Secondary Certificate (SSCE) in Biology in Nigeria: 2002 – 2013

Year	Total Entry	Total Sat	Credit Passes 1-6	Percentage Passes of credit 1-6
	No of Candidates.	No of Candidates	No of Candidates	% of Candidates
2002	1,240,163	882,119	278,112	31.52
2003	1,006,831	909,101	392,249	44.15
2004	1,005,553	1,027,938	253,487	24.69
2005	1,080,162	1,072,607	375,850	35.04
2006	1,170,552	1,152,045	559,854	48.60
2007	1,270,137	1,238,163	413,211	33.37
2008	1,292,910	1,259,964	427,644	33.94
2009	1,372,567	1,340,206	453,928	33.87
2010	1,331,381	1,300,418	427,644	33.90
2011	1,540,141	1,505,199	579,432	38.50
2012	1,695,878	1,672,224	649,156	38.82
2013	1,678,154	1,646,741	850,706	51.66

Source: Statistics Section, West African Examination Council (WAEC) National Office, Onipanu, Lagos, Nigeria (2013)

Table 1.1, shows the fluctuation in the percentage of students that do pass Biology at the Credit level over the examined years (2002 – 2012). For example in year 2002, only 278,112 out of 882,119 students passed at credit level which is 31.52%. In year 2003, it rises up to 44.15% but descended to 24.69% in year 2004. There was an improvement in year 2006 as 559,854 students out of 1,152,045 passed which is 48.60% percentage pass. Since then, the situation has remained the same, even up till 2012. Year 2013 seemed to be fairer a bit.

Table 1.2: Analysis of May/June (WAEC) SSCE Results (Biology) in Oyo State (2006-2013)

YEAR	NO OF CANDIDATE	NO AND % OF A – B3		NO AND % OF A – C6		NO AND % OF D7 – E8		NO AND % OF F9	
		NO	%	NO	%	NO	%	NO	%
2006	59,934	381	0.63	5,502	9.18	11,451	19.10	42,981	71.71
2007	60,344	422	0.69	6,027	9.99	12,225	20.26	42,092	69.75
2008	30,065	831	2.76	5,317	17.68	10,573	35.17	13,334	44.38
2009	24,904	263	1.06	2,709	10.88	4,532	18.20	17,401	61.87
2010	41,845	866	2.07	9497	22.69	8773	21.16	20,227	50.29
2011	45,970	516	1.12	6236	13.57	11362	20.30	38375	66.13
2012	43,164	585	1.36	6586	15.25	2711	6.28	33867	78.46
2013	42940	503	1.17	5317	12384	12543	29.21	25080	58.41

Source: Planning, Research and Statistics Department, Oyo State Ministry of Education, Secretariat, Ibadan (March, 2014)

Table 1.2 shows that the performance of students in Biology in Oyo State was even worse than the situation in the whole nation. By implication, this means that even if the study is not comparing other states yet, it is glaring with the two tables that the situation at the federal level is even fairer than what obtains at the state level. The analysis revealed that the percentage failure in Biology all over the years considered in the state was far greater than the percentage of passes. This poor performance of students in the State calls for an urgent attention.

According to Ajagun (2006) and Daramola (2007), past Senior Secondary Certificate Examination's (SSCE) results have revealed that students perform poorly in science subjects particularly in Biology. Besides, research carried out by Oginni (2009) supported the claim of a low level of performance in science subjects in institutions of learning in Nigeria. Records have also shown that even in schools where necessary facilities for the teaching and learning of science are available; students still perform poorly in Biology. This poor performance has been attributed to a number of factors. Some of the factors, according to West African Examination Council (WAEC) Chief Examiner's Reports, over the years (2003-2009) are, non – adherence to rubrics, wrong spelling of labels and technical terms, shallow knowledge of the subject matter, inability to properly express themselves in English Language, and inability to properly describe experimental procedures involved (Chief Examiner's Report WASSCE 2004, Page 159).

Another factor affecting students' performance in Biology is students' attitudes towards the subject (Simpson & Oliver, 2011). Ajayi, (2007) stated that students' bad attitudes to Biology make them perform poorly in science subjects most especially in Biology. Scott (2006) also supports the view.

Attitude toward science might be viewed as a learned predisposition to evaluate in certain ways objects, people, actions, or as a learned, positive, or negative feeling about science that serves as a convenient summary of a wide variety of beliefs about science. Attitude could also be seen as important because it permits the prediction of science related behavior. Statements such as "I like science," or "I hate

science," are considered to be expressions of attitudes, towards science because they denote a general positive or negative feeling toward the formal study of science.

Attitude towards science is closely related to achievement in science (Martin *et al*, 2010). Positive attitude/favourable attitude may lead to significant/higher achievement in science. The attitude of the teachers, to a large extent, affects achievement and attitude of students in science (Abram, 2004; Adetunji, 2000). Ahmed (2008); Afuwape and Olatoye (2004; 2003) and Amosun (2002) asserted that a number of factors have been identified as related to students' attitude to science. Such factors include teaching methods, teachers' attitude, influence of parents, etc.

Attitude, like achievement, is an important outcome of science teaching. One of the goals of science teaching and biology teaching in particular is to help students develop favourable attitude toward biology and biosocial problems. Researches over the years have established the fact that despite all efforts in teaching biology, students' attitude still remain negative (Okeke, Akusola and Okafor, 2004). A non-challant attitude of some students to biology has been attributed to their poor performance in the subject. According to Aldophes, Fraser, and Aldridge (2003), positive students' attitudes are fundamental to students' positive academic performance in the subject. Fisher (2001), also noted that high levels of learning occur and learners feel good about themselves and the materials they are learning when teachers efficiently use the time of instruction. The way teachers interact with students influences their (students) attitude toward school and their academic performance; how students perceive their teachers' attitudes to teaching in the classroom. This is highly essential and related to students' academic performance (Efunbajo, 2005).

Several research findings have also reported that students in high schools have negative attitude towards science, especially Biology (Ajayi, 2007). From learning theory perspective, students with less positive attitude to science will lack the motivation to persist and do better in this field (Adeoye, 2011; Bandura, 1977). The poor achievement and resultant poor attitude has been attributed to inappropriate teaching strategies (Daramola, 2007). Hence, the need for urgent attention as stakeholders to find the learning strategies that could better enhance students' positive attitude towards Biology.

Students do not possess sufficient practical skills that can aid their problem solving skills (Raheem, 2003). This may have been caused by the instructional strategies used in teaching and learning (especially Biology) which do not promote the development of practical skills. This, therefore, suggests that a self-activity based teaching strategy which facilitates students' participation and active involvement in the learning process would be a viable option for addressing problems associated with students' lack of practical skills in Biology (Ehinkhamenor, 2012). This is what this study seeks to address and have done.

The use of the process of science can bring about students' development of practical skills. Raimi and Fabiyi (2008) also observed that not much work has been carried out on students' acquisition of practical skills.

The low level of achievement among students in Biology coupled with their negative and poor attitude to the subject and the poor practical skills have all been attributed to the inappropriate method of teaching mainly employed by most Biology teachers. Researches have revealed that the teacher-centred strategy normally used by the teachers would not assist the learners to be active recipient of knowledge by which the achievement can be improved (Babayemi, 2014; Ogundiwin, 2013; Huitt & Cain, 2005). These scholars have therefore suggested the use of active strategies to take care of the deficiencies.

Active learning, as opposed to passive learning, involves students who are directly and actively participating in the learning process. This is to say instead of simply receiving information verbally, students are receiving, participating and doing, cumulating into experiences (Awolere, 2006). Krapp (2002) also noted that the goal of education is to communicate effectively to the students, including the nature and magnitude of ecological problems, and array of alternative strategies available for their solution and sufficient insight towards the right attitude and sustainable use of the practical resources. These must be emphasized in biology education.

Experiential education is best understood as a philosophy of education, in contrast to learning methodologies such as didactic or rote learning that are mostly concerned with knowledge delivery. Experientially based learning strategies in general have a long history rooted in the early work of John Dewey (1927), and later was developed by Piaget (1970)), Vygotsky (1978), Kolb and Kolb (1984), and many

others. By definition, experiential learning places the locus of control and focus of the process directly within the learner or learners.

Experiential education is a philosophy of education that describes the process that occurs somewhere between a teacher and student that infuses direct experience with the learning environment and content. The term is not interchangeable with experiential learning, however, experiential learning is a sub-field and it operates under the methodologies of experiential education. In experimental education, students enjoy the opportunity to apply their knowledge and skills by making connections to the real world. Therefore, effective learning entails active experimentation with a hands-on-approach to learning. It is perceived that students learn more by being active. Experiential is having physical experience of an event (Kumuyi, 2014).

Scott (2002) emphasized that most environmental degradation programs are real-life in nature and should be experiential with students writing about what they learned, how they applied it and how they can become a better employee. Kolb and Kolb's (2005) experiential learning theory from which the strategy is derived also aligns with Scott (2002), in that experiential learning and real-life learning are mutually supportive. While the nature of environmental degradation program is similar throughout the country, the inclusion of experiential learning techniques throughout the students' learning experience can provide significant benefit according to Kolb and Kolb (2005). Many educators on environmental degradation have endorsed the application of theoretical knowledge in a laboratory or environmental degradation setting as representing an experiential base that provides students with diverse learning opportunities and experiences. Ogunleye *et al*. (2011) stated that experiential learning aligns with constructivism, which posits that learners construct meaning from their experiences.

In related findings, Berrt (2011), Armstrong and Fukani (2008) supported the experiential focus on secondary biology education by stating that the emphasis was on learning by doing. Olubela (2013), Kimura (2005), further stated that the emphasis on experience is apparent in the attention given to laboratory work, field trips, problem solving, and supervised occupational experience programs. In biology education and other environmental degradation concepts, students acquire the theoretical knowledge

in a classroom and subsequently apply that knowledge to a known situation that calls upon the recently learned knowledge to perform a series of tasks, in an occupational-like setting that authentically relates to the real occupational setting. This process is often embraced as the implementation of research-based experiential learning. While these processes constitute components of experiential learning, the partial application of theoretical experiential learning principles to contextual occupational situations does not embrace the fullest extent of experiential learning (Kolb and Kolb, 2008).

Experiential learning theory is built upon the central notion that experience plays a critical role in the learning process (Kolb, 2004). Experiential learning can also be defined according to Kolb (1984), as the process of creating and transforming experience into knowledge, skills, attitudes, values, emotions, beliefs and senses. Perhaps, the most widely cited experiential learning model is the Kolb Learning Cycle (Kolb, 2004), which is simplified into four continuous stages as shown in Figure 2.1. The learner has a 'concrete experience, the learner makes observations and reflections based upon the experience, the observation and reflections are assimilated into a new conceptual understanding and interpretation of the meaning of the experience and this conceptual understanding is translated into 'actionable knowledge' that is applied and then used to guide new experiences.

Simpson and Olivers (2011) and Barton (2001) argued that knowledge is inherently dependent upon one's understanding of an experience and their ability to use this interpretation to guide future decisions or actions. Learning therefore may be viewed as the process of making a new or revised interpretation of the meaning of an experience, which guides subsequent understanding, appreciation and action. Barton (2001) further contends that, experience strengthens, extends and refines our structures of meaning by reinforcing our expectations about how things are supposed to be. To him, the approach to the experiential learning process is a continuous cycle through experience (or a disorienting dilemma), critical reflection, dialogue and renewed action.

Generative learning strategy is one active strategy to help the learners improve their cold and warm attitude towards biology in particular and science in general. Introductory science courses such as biology, chemistry and earth science are usually required in our learning institutions so as to improve the general attitudes of learners

toward science (Faralinaz, 2012; Jane, 2002; Wittrock, 1974, 1991). In order to make these science courses meaningfully taught, there is a need for learners to be allowed to generate meanings from events.

In generative learning strategy, learners also have facts to give, expressions to make and should therefore be given opportunity and freedom to express their minds and give their personal opinion about the subject matter being discussed. The instructor just has to accept the feeling of his students, appreciate the contribution of the learners, acknowledge and guide the ideas of the students. He also guides factual information by asking the students stimulating questions that can enhance their (students) participation. In Generative Learning Strategy, it is believed that students that interact together and with subject matter build deeper knowledge.

The study by Hyeon *et al* (2003) of Pennsylvania State University shows that "Only through learners' generation of relationships and meaning themselves can knowledge be generated that is sustainable" -this is the essential process of meaning making by the learner. A variety of studies reported on results of generative learning have shown that in most cases, active learner involvement produced increased gains in recall and higher order thinking or improvement in self-regulated learning skills i.e. improved achievement in all areas (Lee, 2008).

Students also develop more general skills. Report writing and presentations also boost communication skills; seminars and projects develop teamwork skills. Other skills developed are organizational skills, self–enhanced initiative, business awareness and strong interpersonal skills. Generative learning strategies stand to give all the enumerated skills in biology (Jolaoso, 2012; Wittrock, 1974).

Direct instructional strategy is the oldest method of teaching used in most Nigerian secondary schools. It is a 'talk-chalk' method. The teacher "gives out" the facts to the students and the students in turn listen and digest the knowledge (Grabowski *et al*, 2006).

There are reasons listed by Adesoji (2004) which make teachers refuse to change their conventional teaching style. Some of the reasons are:

(i) Lack of infrastructural facilities,

(ii) Overloaded curriculum, which normally contains irrelevant topics,

(iii) Lack of training programmes/workshops and also.

Olagunju (2002) also identified other reasons which are:

i. Lack of skills in handling difficult concepts as identified by Olagunju (2002).
ii. Problem of misconceptions about science acquired through traditional African thought and other superstitious beliefs, and
iii. The learning environment. She opined that many learning envinroments are not condusive for proper learning.

All the enumerated problems can be averted with the use of active and students-centered strategies. Olagunju (2002) therefore suggested that the school environment can also be made to be condusive, interesting and captivating to promote effective teaching and learning such that the desired objectives for teaching science could be attained.

There are many intervening or moderator variables that can affect any research work, irrespective of the strategies used. Some of them are gender, the profession of the parents, parental educational background, family income, the areas where they live, mental ability, school type, school location, cognitive style and many more others. This research work adopted gender and mental ability as the moderator variables for the study.

Gender influence on academic achievement and skills acquisition has generated much controverses among researchers. There has been mixed results for gender performance on students' achievements and practical skills acquisition, with boys demonstrating higher-ability skills in some tasks (Okeke, 2007) and girls performing better than boys in practical skills (Awoderu and Oludipe, 2012). However, Oduwaiye (2009); Raimi and Adeoye (2002) found no gender related difference in students' achievement while Agbomian (2002) found no gender differences in acquisition of practical skills.

The implication of these studies is that findings from such studies have not shown definite conclusions whether males or females are better achievers in performance and in the acquisition of practical skills. Therefore, this lack of consensus on the influence of gender on learning outcomes created a gap that makes the need for further investigation imperative. The performance of boys and girls in relation with the instructional strategies designed must then be carried. The critical

belief of biological theorists is that gender differences are natural and unalterable (Olubunmi, 2001).

In the beginning, studies about gender effect on science achievement were anchored on biological differences (different functioning of males' and females' brains). However, now, it has turned out that cultural and social effects are more responsible for making gender an affecting factor of science achievement (Adeoye, 2011; Temizkan, 2003). Research studies have also shown that gender can influence students' achievement in sciences (Linver and David, 2012; Olagunju and Chukwuka, 2008; Idowu, 2008). Olagunju and Chukwuka, (2008) reported that Nigerian boys perform better than girls in basic sciences particularly in Mathematics.

Also, Atwater (2004) found significant gender-group differences in favour of boys. In this regard, most girls have been found to underestimate their own academic ability and believe boys to be superior and more intelligent than they are (Olagunju and Chukwuka, 2008). Solomon (2004), in his study of gender differences and students' achievement in secondary school Biology, found out that boys performed better than girls in all schools taken as a group and a single sex as shown by these mean scores (52.2 for boys and 49.8 for girls), as reported by Ogundiwin (2013).

The effect of mental ability should be of great concern in a study like this. There is the need to still work on mental ability due to inconsistent results in the previous studies conducted on the phenomenon. General mental ability is a term used to describe the level at which an individual learns, understands instructions and solves problems. General mental ability has been found to be the single best predictor of extent of academic performance /achievement of students. Studies have found that students with higher general mental ability acquire more academic knowledge and acquire it faster than others. Also, higher levels of academic knowledge lead to better performance (Ehikhamenor, 2012).

Mental ability has been found to influence performance of students in Biology (Carol, 2009; Olagunju and Chukwuka, 2008; Raimi, 2003; Salami, 2002). Similarly, Jolaoso (2011), while quoting Ajiboye (2002), it was revealled that knowing the intelligence level of learners will to a large extent, determine how much the learner will achieve from a learning process or skills' programme. Against this background, mental ability is a variable in this study. Studies have revealed that students have

varying ability levels which tend to affect learning outcomes (Olagunju and Chukwuka, 2008; Raimi, 2003). Studies have also shown that students of varying ability levels perform differently depending on the types of methods and materials used for instruction (Okafor, 2006). This study investigated the applicability of problem solving instructional strategies to students' learning irrespectively of their varying capabilities.

1.2 Statement of the Problem

The National Policy on Education (FRN, 2004) stipulates that each secondary school student should study at least a science subject. Biology is classified as one of the core subjects that should be offered by students at the senior secondary school examination and actually the most partronized subject among the sciences. Biology occupies a unique position in the school curriculum and central to many science related courses such as medicine, pharmacy, agricultural science, nursing, biochemistry, microbiology and so on. It is obvious that no student intending to study these courses can do so without Biology, and a credit in Biology is a pre-requisite.

As important as the subject is, it is disheartening that students' achievement in the subject at the secondary school level is becoming worse compared to other subjects particularly in Oyo State. Reports from both national and international examination bodies have shown that students record low achievement in the subject; a trend which is probably due to students' poor attitude, low practical skills and teacher-centered teaching strategies. Scholars have thus indicated the need for the adoption of active learning instructional strategies to address this deficiency. By the use of these active strategies, they have also suggested that the level of attitude and success in biology education by students can also improve. Literature have documented the effectiveness of these strategies in enhancing students' learning outcomes in Physics, Chemistry and English Language but not on students' achievement in Biology. This study, therefore, determined the effects of Experiential Learning (ELS) and Generative Learning (GLS) and MC Strategies on students'academic achievement, attitude to and practical skills in Biology in Oke-Ogun area of Oyo State, Nigeria. The moderator effects of gender and mental ability were also examined.

1.3 Hypotheses

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

$H0_1$. There is no significant main effect of treatment on students'

(a) Academic achievement in Biology.

(b) Attitude to Biology.

(c) Practical skills in biology.

$H0_2$. There is no significant main effect of gender on students'

(a) Academic achievement in Biology

(b) Attitude to Biology.

(c) Practical skills in Biology.

$H0_3$. There is no significant main effect of mental ability on students'

(a) Academic achievement.

(b) Attitude to Biology.

(c) Practical skills in Biology.

$H0_4$. There is no significant interaction effect of treatment and gender on students'

(a). Academic achievement in Biology.

(b) Students' attitude to Biology.

(c) Practical skills in Biology

$H0_5$. There is no significant interaction effect of treatment and mental ability on students'

(a) Academic achievement in Biology.

(b) Students' Attitude to Biology.

(c) Practical skills in biology.

$H0_6$. There is no significant interaction effect of gender and mental ability on students'

(a) Academic achievement in Biology.

(b) Attitude to Biology.

(c) Practical skills in Biology.

$H0_7$. There is no significant interaction effect of treatment, gender and mental ability on students

(a) Academic achievement in Biology.

(b) Students' attitude to Biology.

(c) Practical skills in Biology.

1.4 Scope of the Study

Oyo State was chosen as the geographical scope for the study. It was randomly chosen from the states in the old western region, a region that has the opportunity of benefitting from different free education programmes put in place by successive administrations in the nation. For this reason Oyo State is one of the leading states in terms of educational policy and programmes in Nigeria. Nine secondary schools were randomly selected from all secondary schools in the State. In terms of content scope, the selected concepts for the study are Pollution, Ecology, Conservation of natural resources and Population studies. The skills used were selected on the basis that these are the specific areas where the WAEC Chief Examiners in Biology have reported that students do have problems.

The variables used for the study include students' academic achievement in biology, students' attitude to biology and students' acquisition of practical skills in biology (particularly in Oyo State), Nigeria. Gender and mental ability were also examined as the moderating variables.

The participant scope-involved in the study was a total of 428 S.S I students that was chosen from nine intact classes-one intact class per school. The four hundred and twenty eight students involved included 197 males and 231 females.

1.5 Significance of the Study

Over the years, students' performance in Biology has been poor due to the use of conventional/traditional teaching methods. Hence, the need to introduce new teaching strategies, that would help to improve the interest and attitude of students to Biology. This is essential since they result in better academic achievement.

This research is also significant as the outcome of this may popularize and stabilize the use of new strategies that may influence students' performance at the senior secondary level of education in Oyo State. Findings of this study would serve as part of the efforts made by educators in Nigeria to equip students for admission into higher institutions.

The society would also benefit when students' academic achievements improve. This would increase the number of students that would enroll for sciences in higher institutions of learning. Consequently, this would translate to increased manpower in

Biology related fields, leading to improved health, agriculture and other services. It may also serve as an integral part of curriculum innovation in Nigerian education; it is hoped that it would contribute to the existing stock of knowledge for better performances in the subject. The relevance of the strategies calls for their inclusion in the curriculum of senior secondary classes in Nigerian schools. Despite the important place of biology to mankind and its central position in science generally, the learning outcomes of students in the subject is not encouraging.

Finally, findings of the study would be of benefit to authors because they will be able to incorporate the strategy into their texts which will make the texts more applicable to individuals, schools, interested groups and the general society.

1.6 Operational Definition of Terms

Achievement in Biology: This refers to the totality of students accomplishment determined by the pre and post test scores in the Biology Achievement Test (BAT).

Attitude to Biology: This refers to a measure of the opinions, beliefs, feelings, dispositions, emotions, interest and perceptions, which a student has about Biology, as measured by Questionaire on Attitude to Biology.

Biology Practical Skills Rating Scale (BSSRS): This is a scale designed to measure students' practical skills in Biology class. The scale in particular measured observation, recording, drawing, labeling, manipulation of apparatus and classification by the students.

Modified Conventional Strategy: This is the teaching strategy used to teach biological concepts in schools selected for the study. It involved the teacher doing most of the activities in the classroom, like demonstrating, performing experiments and talking during the lesson, while the students remain passive, listening to the teacher and sometimes are allowed to take part in the activities. Students were only allowed to ask two questions in each class.

Environment: This includes all the living and non living elements of man's surroundings. It consists basically of three major components – physical, biological and socio –cultural in all the selected secondary schools.

Experiential Learning Strategy: Experiential learning is a strategy (process) whereby students "learn by doing" and by reflecting on their experience in ecological

concepts. It engages students in critical thinking, problem solving and decision making in ecological concepts.

Generative Learning Strategy: Generative learning is a strategy that involves the active integration of new ideas with the learner's existing schemata. This is a process by which a learner is allowed to generate his or her own learning by integrating new information with current existing knowledge on ecological concepts.

Mental Ability Test: This refers to the test used for the assessment of learners' intelligence in terms of his/her ability to think and reason logically and ability to regurgitate information. Learners attempted the test and the scores were used to classify them into high, medium and low ability groups.

High mental ability group: Learners who scored 60% and above in the Mental Ability Test.

Medium mental ability group: Learners who scored 40% to 59% in the Mental Ability Test.

Low mental ability group: Learners whose score fall below 40% in the Mental Ability Test.

Learning: Learning is an intimate transaction between the learner and his environment. It is a relatively permanent change in human behavior.

Previous experience: This refers to the scientific or non-scientific ideas students have before their exposure to new strategies used for the study.

Teaching: This refers to a system of actions intended to induce learning i.e teaching in this study relates to what was learnt in this study.

CHAPTER TWO
LITERATURE REVIEW

The main objective of this chapter is to review literature related to the present study. This chapter would be categorized into the following areas or theme.

2.1 Theoretical Framework

2.1.1 Constructivist Learning Theory

2.1.2 Cognitive Theory of Learning

2.1.3 Experiential Learning Model

2.2 Conceptual framework

2.2.1 Experiential Learning Strategy

2.2.2 Generative Learning Strategy

2.2.3 Modified Conventional Strategy

2.2.4 Academic Achievement in Biology

2.2.5 Attitude to Science

2.2.6 Skills in Science

2.2.7 Gender in Science

2.2.8 Mental ability in Science

2.3 Empirical Review

2.3.1 Experiential Learning and Students' Achievement in Biology

2.3.2 Experiential Learning and Students' Attitude to Biology

2.3.3 Experiential Generative Learning and Students' Skills in Biology

2.3.4 Generative Learning and Students' Achievement

2.3.5 Generative Learning and Students' Attitude to Biology

2.3.6 Generative Leaning and Students' Skills in Biology

2.3.7 Modified Conventional Strategy and Students' Learning Outcomes

2.3.8 Gender and Students' Learning Outcomes in Biology

2.3.9 Mental Ability and Students' Learning Outcomes

2.4 Importance of Science Teaching

2.5. Appraisal of Literature.

2.5.1 The Present Study.

2.1 Theoretical Framework

2.1.1 **Constructivist Learning Theory:** The two strategies under consideration (Experiential and Generative learning strategies) are based on Constructivist Learning Theory.

Constructivism can be described as a theory that deals with the way people create meaning of the world through a series of individual constructs. Brunner, (1960) describes constructivism as a theory of knowledge with roots in philosophy, psychology and cybernetics. It is a learning process which allows a student to experience an environment first –hand, thereby giving the students reliable, trust –worthy knowledge.

Going by the constructivist approach, knowledge is an entity which is mentally constructed through the action and experience that the learner undergoes. Knowledge is discovered by students and transformed into concepts that students can relate to. According to Jegede (2007), such knowledge is then reconstructed and expanded through new learning experiences.The constructivist theory, as proposed by Bruner (1960) and Craker (2006), is premised on the active nature of learning. Bruner sees a large number of students in the science class with lots of ideas about science concepts, many of which are 'incorrect', 'naïve' or are alternative frameworks. One of the aim of science teaching then is to help students overcome naïve conceptions or habits of thought and replace them with scientific concepts and principles.

The underlying conception of constructivism is that knowledge resides in the individual learner, and as such, learning is a process through which an individual tries to make sense of what is taught by fitting it into his or her existing knowledge (Ogundare, 2008). Knowledge, therefore, should not be divided into different subjects or compartments but should be discovered as an integrated whole (Ogundare, 2008). Learners should constantly be challenged with tasks that refer to skills and knowledge just beyond their motivation and it should build on previous successes to enhance learners' confidence (Ogunleye *et al*, 2011). This is

in line with Vygostky's (1978) zone of proximal development, which can be described as the distance between the actual developmental level (as determined by independent problem solving) and the level of potential development (as determined through problem–solving under adult guidance or in collaboration with more capable peers) (Adesoji, 2008).

To fully engage and challenge the learner, the task and learning environment should reflect the complexity of the environment that the learner should be able to function in at the end of learning. Learners must not only have ownership of the learning' or problem –solving process, but of the problem itself (Efunbajo, 2005). Where the sequencing of the subject matter is concerned, it is the constructivist's viewpoint that the foundations of any subject may be taught to anybody at any stage in some form (Salta and Tzougraki 2004). This means that instructors should first introduce the basic ideas that give life and form to any topic or subject area, and then revisit and build upon these repeatedly.

Constructivists see learners learning by experimentation, and not by being told what will happen; leaners are left to make their own 'inferences', 'discoveries' and 'conclusion'. It is also important to draw upon relevant previous experiences of learners in teaching new materials. A new learning material must fit with what a learner already knows if it is to be well understood (Smith, 2001). This means that a teacher either will help the students to build relevant prerequisite knowledge or refresh their knowledge before they are exposed to new materials. Mcdermott (2011), Abimbola and Baba (2006), and Hartman and Glasgrow (2002) describe a situation where students come to the class with their 'naïve theories', 'misinformation or misconceptions' about science. These misconceptions may hinder their learning; therefore, it is important that a teacher anticipates the misconceptions and misunderstandings and then take measures to clarify them. For effective learning to take place, it then involves one constructing one's own knowledge from one's own experiences (Ormrod, 2003).

This theory is relevant to both experiential and generative learning strategies in the sense that it views learning as a personal endeavour, whereby internalized concepts, rules and general principles may consequently be applied.

2.1.2 Cognitive Theory of Learning: A Theory on Mental Ability

Cognitive theories of leaning had their roots in Gestalt psychology. Gestalt theory emphasizes the important mental processes. From a cognitive learning perspective, learning involves the transformation of information in the environment into knowledge that is stored in the mind. Learning occurs when new knowledge is acquired or existing knowledge is modified by experience. Among the main issues studied and discussed by cognitive psychologist are:

- The cognitive theories present a positive view of development, emphasizing conscious thinking,
- The cognitive theories (especially Piaget's and Vygotsky's) emphasize on the individual's active construction of understanding,
- Piaget's and Vygotsky's theories underscore the importance of examining the developmental changes in children's thinking, and
- The information processing theory offers detail descriptions of cognitive processes.

According to Piaget (1970), a psychologist, learning can take place by discovery or insight. The idea is to produce students who could think like scientists through discovery, inquiry learning and active student involvement. According to Burner (1973), (who was an influential psychologist) students learn best by discovery and the learner is a problem-solver who interacts with the environment and tests hypotheses. Acquisition of problem –solving skills is the goal of science curriculum: inquiry and discovery. Bruner said that knowing is a process rather than the accumulated wisdom of science as presented in textbooks. To him, to learn science concepts and solve problems, students should only be presented with perplexing situations and be guided by intrinsic motivation so that the learner himself will figure out the solution.

Just as children undergo remarkable physical changes during their development, their cognitive abilities also progress through fundamental transformation. Cognitive development refers to a mental process by which knowledge is acquired, stored and retrieved to solve problems. Therefore, cognitive developmental theories attempt to explain cognitive activities that contribute to children's intellectual development. In order to appreciate how cognitive developmental theories have contributed to educational technology design, process and development must be considered (Huitt, 2009; Ontario Ministry of Education, 2007; Smith, 2001; Piaget, 1970). According to Piaget (1970), a child passes through the following stages in life:

1. Sensory – motor (birth to 2years)

A child make use of sensory and motor ability to form concepts about the world around him/her, and gains understanding of him/her environment through direct interaction. He or she recognizes concrete objects as a result of interaction with them, learns to coordinate movements and begins to develop mental representations of information.

2. Pre- Operational stage (2 -7 years)

This is the second stage in which a child grapples with conceptualizing concrete physical environment and accumulating physical experiences. At this stage, the child responds to objects and events as they appear to be, and develops the ability to represent them symbolically "inside of himself in such a way that the representations can be used in the absence of the object" (Viadero, 2006, p. 66).

3. Concrete Operational stage (7 – 11 years)

This is the stage when a child begins to conceptualize and create logical structures to explain his or her own physical experiences. At this stage, the child is able to do a bit of abstract activities and mental operations as well as do some logical reasoning.

4. Formal Operational (11 years upward)

This is the final stage when a child's cognitive structures are getting developed for abstract conceptual thinking. Here, he learns to carry out abstract operations, develops critical thinking and undertakes problem solving at a formal, logical level.

Each child navigates through these stages at a different pace and accumulates experiences to reason logically. There are various implications of this circle for the teaching of science (Biology inclusive). The implications are

i. Subject matter in biology should be structured in a hierarchical and logical manner to provide a build – up of experiences,
ii. Selection of instructional experiences should be guided by individual differences amongst the learners, and
iii. There should be a wide range of opportunities for students to interact with and explore their immediate environment (Ogundiwin, 2013).

2.1.3 Experiential Learning Model

This is a type of learning which is experience–based. John Dewey, Kurt Lewin, Jean piaget, Carl Jung, Maura Lewis, Jane Winberg, David Kolb, Richard Boyatzis and many more learning theorists share the same opinion that "experience is central to learning" (Kolb and Kolb, 2005). In Kolb's model, the process of learning is divided into four stages, all of which must be explored for learning to be most effective. A brief description of these stages follows.

Concrete experience: This provides the basis for the learning process. Lesson at this stage engages the individual personally and learning relies on open-mindedness and adaptability rather than a systematic approach to the situation or problem

Reflective observation: This is used to make sense of the experience. At this stage, students consider their concrete experience from a variety of perspectives, and articulate why and how they occurred. Learning occurs as a result of patience,

objectivity, careful judgement, and observation. Reflection helps students break their experience into parts to categorize them for use in the next stage of learning

Abstract conceptualization: Here, a student assimilates and distills the observations and reflections into a theory or concept. At this stage, students come to understand the general concept of which their concrete experience was one example by assembling their reflection on the key part of their experience into a general model. Abstract conceptualization requires students to use logic and ideas to understand situations and problems. Students can require considerable help from the instructor to proceed through this stage.

Active experimentation tests: The theories lead into new experience. In this step, students use the theories they developed during the abstract conceptualization stage to make predictions about the real world and then act on those predictions.

Experiential learning is a well – known model in education. In Kolb's Experiential Learning Theory (Kolb, 1984), he defined experential learning as a situation whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience.

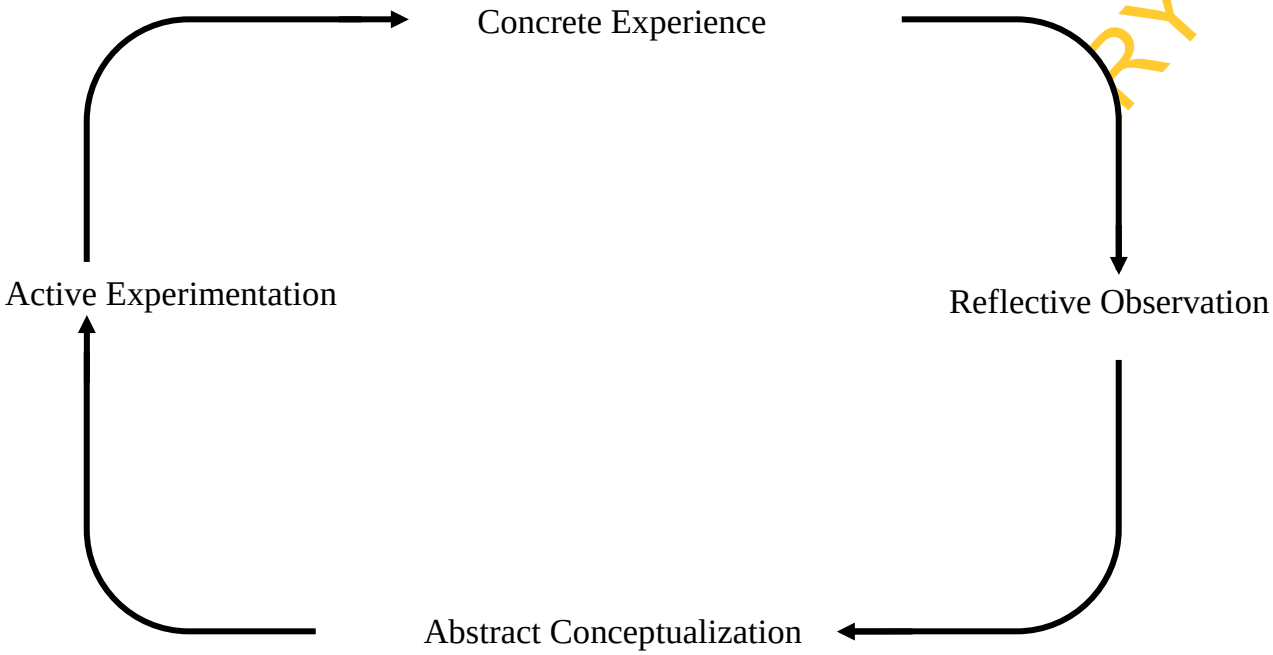

Figure 2.1 Kolb's Experiential Learning Model

Source: Kolb's Learning Theory, 1984

Kolb's Experiential Learning Theory presents a cycle of four elements

1. Concrete Experience
2. Reflective Observation
3. Abstract Conceptualization
4. Active Experimentation.

The cycle begins with an experience that the student or learner has had, followed by opportunity to reflect on that experience. Then, students may conceptualize and draw conclusions about what they experience and observe, leading to future actions in which the students experiment with different behaviours. This begins the cycle anew as students have new experiences based on their experimentation (Fredrick, 2014). Although this continuum is presented as a cycle, the steps may occur in nearly any order. This learning cycle involves both concrete components (steps 1 and 4) and conceptual components (steps 2 and 3), which require a variety of cognitive and affective behaviours.

Experiential learning is both a holistic model of the experiential learning process and a model of adult development (Kolb and Kolb, 2005). The theory provides a framework for understanding both the cyclical nature of experiential learning and individual learning tendencies, the latter being referred to as learning style. Experiential learning theory suggests that learning is a complex and adaptive process integrating a range of mental processes.

Awolere experiential learning model was developed (and used for the study) from Kolb's experiential learning model and was shown in Figure 2.2. This model has seven steps unlike that of Kolb's which was made of four steps.

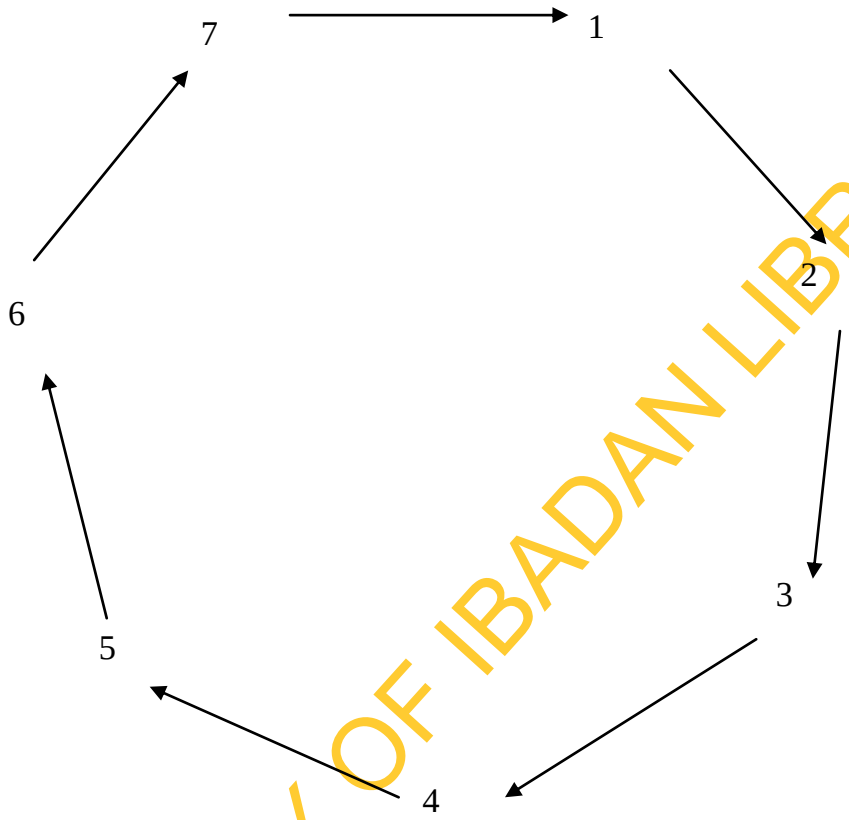

Figure 2.2 Awolere 's Experiential Learning Model

Source : Awolere 2015

Where 1 = Introduction and Grouping of Students,

2 = Concrete Experience,

3 = Reflective Observation,

4 = Abstract conceptualization,

5 = Active experience

6 = Conclusion and application and

7 = Summary

2.2 Conceptual Framework

2.2.1 Experiential Learning Strategy

Experiential learning is the process whereby knowledge is created through the transformation of experience (John, 1991). Dewey (1927) emphasized that; there must be a relationship between experience and education. Dewey stresses that there is to be a 'having' which is the contact with the events of life, and a 'knowing', which is the interpretation of the events. A learning experience does not just happen; it is a planned event with meaning and with experiential learning, the meaning is reaffirmed by the learners (Bart Beaudin et al, 2005). Experiential learning is inductive, learner centred and activity oriented.

Experiential learning has been a major component of career and technical education for many years; its implementation has not been considered (Robert, Mark and John, 2010). Experiential learning according to Robert et al, (2010) is a true learning strategy for students and it is valued by employers. It engages the learner at a more personal level by addressing the needs and want of the individual. It employs the whole learning wheel, from goal setting, to experimenting, and observing to reviewing and finally action planning. This complete process allows one to learn new skills, new attitudes or even entirely new ways of thinking. When students participate in experiential learning, they frequently follow what is known as "the learning cycle." This is a process, based on constructivist theory, which starts with unstructured exploration, followed by what development theorists call concept formation and concept application.

Experiential learning is the process of making meaning from direct experience. Simply expressed, experiential learning is learning through reflection on doing (active participation), which focuses on the learning process for the individual. For example, a learner on ecological trip to the natural habitats of organisms will learn better due to his/her interaction with the environment, as opposed to reading about the organisms from a book.

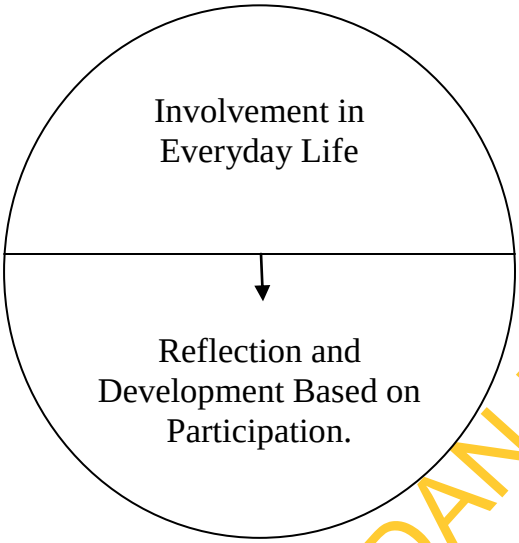

Figure 2.3 Degree Of Direct Student Involvement In Various Teaching Methods.

Source: Kolb's Experiential Learning Theory (1984)

Experiential learning requires no teacher and relates solely to the meaning making process of the individual's direct experience. However, even though the gaining of knowledge is an inherent process that occurs naturally, for a genuine learning experience to occur, there are certain elements that must exist. An American educational theorist called David Kolb described knowledge as being continuously gained through both personal and environmental experiences. He states further that, "in order to gain genuine knowledge from an experience, certain abilities are required". These abilities are:

a. The learner must be willing to be actively involved in the experience;
b. The learner must be able to reflect on the experience;
c. The learner must possess and use analytical skills to conceptualize the experience; and
d. The learner must possess decision making and problem-solving skills in order to use the new ideas received through the experience.

Experience learning is about creating an experience where learning can be facilitated. As a facilitator, you should believe in the creed: How, "you teach some by what you say, teach more by what you do, but most of all, you teach most by who you are". And while it is the learner's experience that is most important to the learning process, it is also important not to forget the wealth of experience a good facilitator also brings to the teaching – learning process. An effective experiential facilitator is the one who is passionate about his or her work and is able to immerse participants totally in the learning situation, allowing them to gain new knowledge from their peers and the created environment (Jegede, 2012). Experiential learning is the process whereby students "learn by doing" and by reflecting on the experience. Its activities can include, but are not limited to hands-on laboratory experiments, field exercises, and studio performances.

Experiential learning can be a highly effective method of improving the teaching – learning process in education. This is because, it engages the learner at a more personal level by tackling the needs and wants of the individual. This

learning method requires qualities, like self – evaluation and for its true effectiveness, it employs the whole learning wheel ranging from the goal setting to experimenting and observing, to reviewing and finally action planning. With this complete process, one learns new skills, new attributes and even new ways of thinking (Baumgartner, 2007). Experiential learning helps students to do critical thinking, problem solving and decision making, in contents that are personally relevant to them (Silberman, 2007).

Many educational research studies have also been focused on the theoretical underpinnings of experiential learning, especially Kolb's research on experiential learning theory published in 1984 and that of Ontario Ministry of Education (2007). The term experiential learning is a broad term, generally used by educators to describe a series of pragmatic activities sequenced in such a way that it is thought to enhance the educational experience of the student-learner. The direct experiential encounter with a learning event requires active engagement of the students as opposed to passive engagement commonly associated with teacher-directed instruction that generally results in minimal student interaction in the learning process. Traditional schooling views the teacher and text as experts and the learner as a passive recipient of that expertise. By contrast, experiential learning promotes involvement in the real world and defines the teacher's role as facilitator of learning. The process of learning takes precedence over the behavioural outcomes, and is based on the premise that learning is a continuous process, with experience at its foundation.

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Characteristics of Experiential Learning

In developing a learning activity, it is good to understand what characteristics make the activity an experiential learning event. Bart et al, (2005) describe several underlying attribute that define an experiential learning activity:

a. Action – the learner is not a passive receptacle but an active participant; and there is physical movement, not just sitting.

b. Reflection – learning only occurs after the action is reflected upon.

c. Phenomenological – objects or situations are described without assigning values, meanings or interpretations, the learner must ascribe meaning to what is going on; and the facilitator's meaning must not be automatically focused upon by the student.

d. Subjective human experience – It involves a view of the world that is the learner's not the facilitator's.

e. Human experience is a source of learning – "experiential learning then is an attempt to make use of human experience as part of the learning process" (p. 14)

Bart et al (2005) and Zacharia and Barton (2004) feel that experiential programs must have the following overarching characteristics.

1. Student – based rather than teacher – based: The learning encounters start with the students ideas and concepts rather than the teacher's or the book's.
2. Personal not interpersonal nature: Personal experiences and personal growth are valued in the classroom.
3. Process and product orientation: Emphasis placed as much on learning as it is on the 'right' answer.

4. Evaluation for internal and external reasons: Assessment is considered to be a learning experience that the students can learn to do on their own.
5. Holistic understanding and component analysis: Students are urged to fully understand the content through the analysis of primary sources of the material and or experiences with the material.
6. Organized experiences: These are taken into account when creating the curriculum, as well as new experiences that will be provided in the classroom, laboratory or field trip.
7. Perception-based rather than theory –based: Experience learning emphasizes a student's ability to justify or explain a subject rather than recite an expert's testimony.
8. Individual based rather than group based: Group identity and socialization skills are stressed, however, emphasis is placed on the individual learning within the group rather than on the group as a whole i.e. criterion referenced rather than norm-referenced.

2.2.2 Generative learning strategy

Generative learning strategy involves the active integration of new ideas with the learner's existing schemata (Ogunleye et al, 2011). Generative learning focuses on selecting appropriate, learner – centered instructional activities. The strategy is one that combines the importance of learner and instructional strategy. Because of the similarities that exist, generative theory can be called a practical cousin of constructivism (Rennie, 2000). It also provides a more complete perspective about learning. The theory brings together our understanding of learning processes and the design of external stimuli or instruction.

Wittrock (1974) emphasized one very significant and basic assumption: The learner is not a passive recipient of information; rather he or she is an active participant in the learning process, working to construct meaningful understanding of information found in the environment (Gray and John, 2011; Huitt, 2011; Hyeon, 2005). Although a student may not understand sentences spoken to him by

his teacher, it is likely that a student understands sentences that he generates himself (Ogunleye et al, 2011).

Designing an instructional strategy based on this basic assumption of 'learning through the person', it is however not as simple as it may first appear. Wittock built his model around four parts based on a neural model of brain functioning according to Krapp (2002) and cognitive research on the process of knowing according to Wittock (1974). It is important therefore to elaborate on the interrelationship of the four parts to Wittock's model: generation, motivation, learning and knowledge creation. Metacognitive processes also play a key role in this model, although in most cases, Wittock folds metacogintive into the knowledge creation process.

Learners, who are motivated to generate meaning between their memory and new information according to Ogunleye et al, (2011) need to use various learning strategies from simple coding to integration strategies. Depending on their motivation level or memory, such as prior learning on domain or learning strategy or learners' preference, learners employ different learning strategies in knowledge generation. This process can be better explained by information – processing theory: the process of thinking and memory storage.

The emphasis of generative learning theory is on the generation of new conceptual understandings, not just on transferring information (Hyeon et al, 2003).

Generative learning is an educational process whereby a learner actively generates ideas on his or her own. It is an environment-based theory suggesting that, instead of solving a pre-defined problem, learners are allowed to generate their own learning by:

- Generating their own problems, and
- Then solving the problems.

Finally, Wittrock (1991) emphasized that learners should control their own generative processes. Self – monitoring is a vital process here because it informs

learners about their progress (Chukwuka, 2005; Yorks, 2002). Based on self – monitoring, learners manage their effort and available resources and change their learning strategies to generate meaning. To round it up, to make meaning, they (the learners) actually create relationship among or between their memory and new information. They are mentally active and use various learning strategies in this knowledge generation process.

Generative learning strategies is of great significance in research work in that the activities i.e generative learning activities, must provide the students with an opportunity to mentally "play with" information to create a personal understanding of the subject to be learned. In generative learning, learners need to make their own meaning by integrating new information with current existing knowledge, rather than just transferring the presented information into memory (Grabowski, 2004).

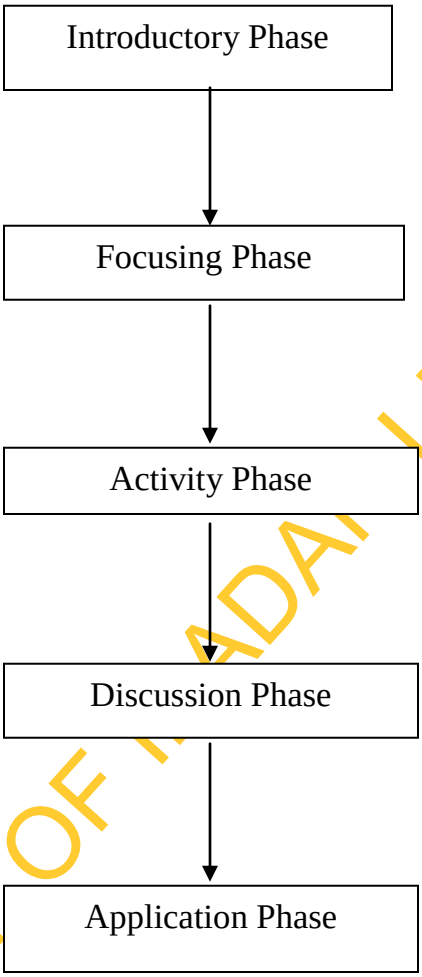

Figure 2.4 : Witrock Generative Learning Model

Source: Witrock 1974

The model when adopted from Witrock was later adapted to form the researcher's model, called Awolere's model of Generative Learning Strategy, (Figure 2.5). This was made of seven components unlike that of Witrock which was made of five components.

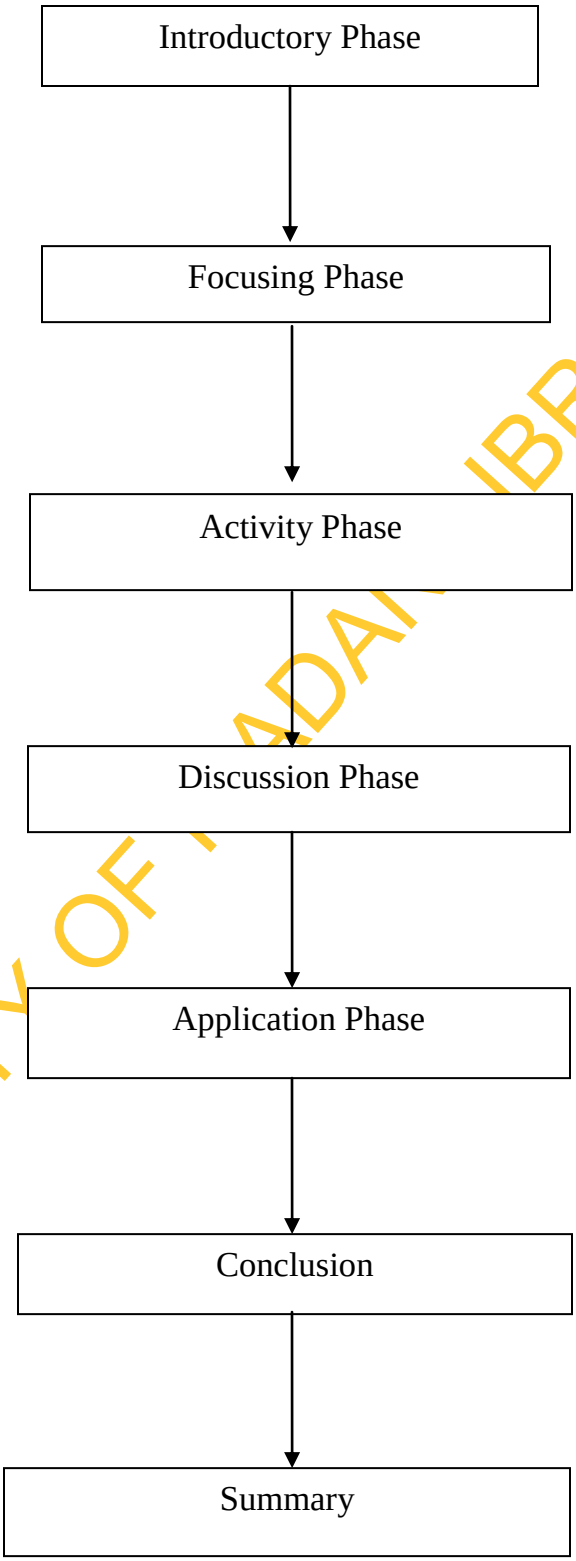

Figure 2.5 Awolere model of Generative Learning Strategy

Source: Awolere, 2015.

2.2.3 Modified Conventional Strategy

According to National Teachers Institute (2011), the approach to teaching in Nigeria is teacher – centered which implies that teacher does all the talking, and the learners do all the listening. Learners expected that the materials and method of instruction should be easily transferable to the real world. It was noted that the traditional or the conventional instructional method is characterized by;

i. Unspecified or vague objectives
ii. Emphasis on instructor behavior rather than students' behaviour
iii. Use of lectures to provide critical information
iv. A constant instruction – set pace for all students
v. Evaluation which is infrequent over large sections of materials, and for the purpose of assigning elative standing rather than for remediation.
vi. Delayed feedback to students about his performance
vii. Ministerial responses of students to the instructional materials
viii. Few faculty or students or teacher to students interaction and observed that one of the major problems militating against effective teaching of secondary school subject in Nigeria is the method of teaching or package adopted by the teachers.

Abimbola, (2013) agreed that Teacher centered Methods of teaching science predominate in Nigeria secondary schools. Blair, Schwartz, Biswas & Lewlawong (2007) expressed their opinions that the conventional strategy of teaching science is inadequate for effective learning in science. Olatoye &Adekoya (2010), James & Olajide (2011) and Oludipe & Oludipe (2010) in previous studies relating to methods of teaching science in Nigerian secondary schools also express the opinion that the conventional method of teaching science is ineffective.

2.2.4 Academic Achievement in Biology.

The poor performance of students in Biology has attracted educators' comments and concerns (Ogundiwin, 2013; Abimbola and Ganiyu 2007; and Adeyemi, 2006). The findings of Daramola's (2007) study revealed that despite all efforts made so far, the level of achievement in Biology remained low i.e. students' performance was still very poor. It is therefore necessary to determine how to improve the achievement of students writing Biology in Senior Secondary Certificate Examination. This is because improvement in their performance level will give them future opportunity to study related courses like nursing, medicine, microbiology, botany, radiology, pharmacy among others

Achievement in teaching/ learning process has to do with attainment of set objectives of instruction. In science instructions for instance, if a learner accomplishes a task successfully and attains the specified goal for a particular learning experience, he is said to have achieved. The attainment of the goal of science education is a major concern of education policy and this is one of the major concerns of scientific literacy (FRN, 2013). A number of factors have been identified as militating against students' attainment of the objectives of science instruction, but the commonest factor identified by researchers is lack of knowledge of the nature of science among students which should be the basic fundamental principle of science. Another factor is the inappropriate and uninspiring teaching methods adopted by teachers (Eyitayo, 2012).

The decline in the performance of students in science in the recent years especially in Biology calls for concern. Sjoberg and Schreiner (2005) reported that of about 45,000 candidates that sat for the certificate examination in Biology in West Africa annually, only half pass Biology and less than 10% of the half that passed Biology scarcely score higher than A grade. To corroborate the above, a study on the performance of science students in ten old established secondary schools in Ogun state for a period of three years (1979, 1980 and 1981), showed that of the three science subject (Physics, Chemistry and Biology), Biology has the

highest failure rate of 51%, Chemistry followed with 47% and the least is Physics which is 40% (Bilesanmi-Awoderu, 2002). A review of empirical studies by Ogundiwin (2013) on biology education at the secondary school level from 1974 to 1984 showed that students had poor understanding of many concepts in Biology such as excretion, genetics, growth, photosynthesis, reproduction and respiration.

Science is widely recognized as a difficult subject (Yussuf and Afolabi, 2010). Many empirical studies have reported that students encountered great difficulties in comprehending the theoretical scientific concepts and principles in Biology (Yara, 2009; Okeke et al, 2006; Fisher 2001).

Indeed, the complexities of science concepts also pose serious challenges to teachers in their attempts to impart that knowledge to the students. Like students, teachers had been reported to have serious misunderstanding of some of the science concepts (Chang, Chen and Sung, 2002). This has a serious repercussion when the wrong concepts are conveyed to the students as a result of teacher's lack of deep understanding of the subject matters. Another problem is shallow knowledge due to inaccurate teaching or inability to use the science textbooks (Ogunleye et al, 2011).

There are many causes of mass failure of students in Senior Secondary School Biology examination. Garba (2009), observed some of these; they are Structuring of the curriculum, concentration of examination questions on few topics and inability of students to perform enough practical before the examinations. He also added that most of the textbooks used in secondary schools are written by foreign authors, languages used in some of the texts are complex and ambiguous, and hence, it becomes difficult for students to comprehend. Many secondary school students are unfamiliar with more than half of laboratory apparatus and are unable to know in what experiment they are used (Jolaoso, 2012). Another cause is the teacher's methodology (Ajayi, 2007). He described the strategies been used by the teachers as being teacher-centred, instead of being students-centred that will be of help to them.

The desire to know the causes of the poor performance in Biology has been the focus of other researchers for some time now. It has been observed that among other reasons that poor performances in sciences are caused by the poor quality of science teachers, overcrowded classrooms, and lack of suitable and adequately science equipment (Kareem, 2003). A recent study has revealed that many aspects of school science (Biology included) are difficult for students to understand, because of the teaching methods used and lack of adequate instructional resources (Huitt, 2009, 2001; and Kiboss, 2003).

Consequently, many students fail to perform well in science because of their inability to organize materials sufficiently in the time allowed for the study and retention (Jolaoso, 2012). Students perform poorly in Biology because Biology classes are usually too large and heterogonous in terms of ability level. In addition, the laboratories are ill-equipped and the Biology syllabus is over loaded (Ahmed, 2008; Okebukola, 2002). It is therefore pertinent to look for variables that could be manipulated to rectify this situation and subsequently find their effects on learning outcomes, and address the problems of teaching and learning of Biology in senior secondary schools.

In the same vein, the WASSCE Chief Examiner's Report also identified other factors as drawing of poor diagrams with loss of details, non conformity to size specifications in diagrams, wrong spellings of labels, omission of titles to diagrams, poor performance in questions on Ecology and Genetics (WASSCE Report November/December, 2007, Page 180). Others are: poor handwriting making students' work illegible, poor numbering of questions, inability to relate structure to function, not writing magnification to diagrams, guidelines drawn with free hand and crossing each other. (May/June, 2007 WASSCE Report, Page 181)

In the Chief Examiner's Report, some remedies were suggested to overcome the persistent failure in the same WASSCE. It emphasized that candidates should prepare adequately for examinations (WASSCE Chief Examiner's Report, November/December 2007); teachers should teach candidates

to draw biological diagrams according to the rules and regulations; ecology should be well treated and should include practical lessons and field trips; Biology teachers should make lessons lively with the use of pictorial charts and models in teaching. Also, students should be exposed to practical classes that will make the teaching more interesting (May/June 2007). Teachers should endeavour to complete the syllabus before the examinations; workshops should be organized to help teacher become proficient in teaching ecological concepts.

However, insufficient resources for the teaching and learning of science constitute a major cause of student underachievement in Biology. The insufficient resources include laboratories, science equipment, and specimens to be used as teaching aids (Yusuff and Afolabi, 2010). Shortage of qualified and dedicated teachers is also a factor affecting students' performance in science and that poor practical orientation will lead to poor understanding of the theory. In his opinion, Eyitayo (2011) observed that teachers are no more dedicated to their assignments. They give more time to trading, petty contracts, farming etc. They sneak in and out of the classrooms and laboratories at will.

A research on the relationship between classroom control and students' performance revealed that teachers who are sufficiently equipped with strategies that adequately assist in classroom control will automatically encourage the students to have full concentration, which will lead to positive academic performance of the students (Atilla, 2011; Garba, 2009). Lack of qualified teachers, lack of facilities and poor teaching method are factors to be considered when students' performance in science is considered. He said the success of any science education programme depends to a large extent on the teacher and his method of teaching. As many as these causes are, the researcher is intending to base this research work on the teacher's methodology; hence the need to make use of more active and cooperative teaching strategies in improving students' achievement in Biology.

2.2.5 Attitude to Science.

Attitudes are mental predispositions toward people, objects, subjects, events, and so on. In science, attitudes are important because of three primary factors (Martin, 2010). First, a child's attitude shows his/her a mental state of readiness. With a positive attitude, a child will perceive science objects, topics, activities, and people positively. A child who is unready or hesitant for whatever reason will be less willing to interact with people and things associated with science. This readiness factor occurs unconsciously in a child, without prior thought or overt consent.

Second, attitudes are not innate or inborn. Contemporary psychologists maintain that attitudes are learned and are organized through experiences as children develop (Craker, 2006). Furthermore, a child's attitude can be changed through experience; and teachers and parents have the greatest influence on science attitudes (Martin et al, 2010).

Third, attitudes are dynamic results of experiences that act as directive factors when a child enters into new experiences. As a result, attitudes have emotional and an intellectual tone, both of which lead to decision making and formation of evaluations. These decisions and evaluations can cause a child to set priorities and hold different preferences.

Attitude, according to Ajitoni, Adu and Amosun (2005), is the acquisition of certain feelings about something or someone, either positive or negative that influences his /her choice of action in a consistent way. Extensive research has shown that a person's attitudes are learned, as opposed to being inherited. Adesoji (2008) opined that a number of factors have been identified as related to students' attitude to science. Such factors include teaching methods, teacher's attitude, influence of parents, gender, age, cognitive styles of pupils, career interest, societal view of science and scientist, and social implications of science and achievement. The impact of a student's attitude toward science is incredibly important (Farahnas, 2012). Attitude as a factor could be viewed as the totality of

an individual's inclination towards object, institution or idea. Kerlinger, according to Wilson et al (2009), opined that it is an organized predisposition to think, feel, perceive and behave toward a referent or cognitive object. Attitude could be learnt or formed and acquired from member of the family, teacher and peer group (Huitt, 2011; Ajiboye and Tella, 2007; Siegel and Ranney, 2003)

The learner acquires so much from the teacher's disposition to form attitude towards learning which could positively or negatively affect his performance. Daramola (2007) posited that behaviours are acquired by watching another person who could be the parent, teacher or a peer group member performing the behaviour. Teachers are role models to the students because as they act, so do the students demonstrate and perfect such act or behaviour. It is very unfortunate that little did many teachers realize that the manner they handle the teaching of Biology as a subject; behave and interact with the students as Biology teachers could produce major effect on students' achievement.

Some teachers seem to have developed negative attitude towards teaching the students this subject (Biology) that is very vital to human living. This might have been responsible for the negative attitude developed towards learning biology by the students. Duyilemi (2006) argued that some science teachers showed positive attitude towards teaching science subjects while some exhibited negative attitude towards teaching science subjects to the students. Agbomian (2002) and Baldi (2001) have argued that the extent a student prefers a subject, to that extent the student works hard to achieve in it. A close examination of the submissions of Baldi, (2001) revealed that academic achievement may be partly dependent upon positive attitude from the teachers and the students in the teaching/learning process.

Attitude is a variable that influences the achievement of students (Iroegbu, 2002; Ajiboye, 1997). Soltani and Nasr (2010) emphasized the fact that there is no statistically significant difference between attitude towards Biology and students' achievement in the subject. The concept of attitude is not only indispensable to

social psychology but also to the psychology of personality and that of learning in general. The concept of attitude arises from an attempt to account for observed regulations in the behaviour of individual persons. The quality of one's attitude is judged from the observable and evaluative response one tends to make. More often than not, attitude held by others are not directly observable; they must be inferred from behaviours (Idowu 2010).

Attitude is predispositions of classified sets of objects or events and which is reacted to with some degree of evaluative consistency. While attitudes logically are hypothetical, they are manifested in experience, verbal reports, gross behaviour and psychological system (Idowu, 2010). Ajiboye, et al (2005) defined attitude as a mental predisposition to act and it is expressed by evaluating a particular entity with some degree of favour or disfavour. Students generally have attitude that focus on objects, people or instruction. According to Idowu (2010), attitudes consist of four components namely, cognitive, affective, behavioural and evaluative components.

Science educators have struggled with defining science attitude and differentiating among attitudes, beliefs, and values (Martin, 2010). The concept of "attitude" is defined broadly as used in the science educational literature. Oliver and Simpson (2008) define it as the degree to which a student likes science. Salta and Tzougraki (2004) summarized attitude as a tendency to think, feel, and act positively or negatively toward objects in our environment. In the views of Salta & Tzougraki (2004), attitudes have three main components: congnitive, affective and behavioural components.

Osborne, Simon and Collins (2003) have identified many features that influence one's attitude: gender, structural variables (e.g. socio-economic class), classroom/teacher, and curriculum. Similar result of an analysis by Barton and Yang (2004) also showed that school variables (particularly classroom variables) such as how well students like their teachers, the science curriculum being used, or

the science classroom climate, are key on attitudes toward science. Barton et al (2004) posited that students and the learning environment do relate together.

Regarding the relationship between attitude and other constructs in the teaching and learning of science, Siegel and Ranney (2003) reviewed other studies and found that: (i) attitudes affect students' persistence and performance (ii) there are modest positive correlation between science attitude and science acheivement; and (iii) activity – based and issue-oriented science instruction enhance positive attitudes toward science. It has also been found that the quality of school science instruction is a significant determinant of attitudes (Olatundun, 2009). One important finding of attitude research is the establishment of a relationship between attitudes and science, and students' achievement and science experiences (Cannon and Simpson, 2005).

It has been revealed through many researches that if the level of attitude and success in Biology education by the students will increase, new teaching methods and technology need to be implemented (Akereja, 2011; Ajitoni and Olubela 2010; Bart and Don, 2005 and Nwagbo, 2002). Six strategies identified by Okebukola, Akpan, Ahove, Kola-Olusanya & Ogunsola and Bandele as quoted by Ogundiwin (2013) are potentially effective for teaching some selected environmental concepts in Biology. These strategies are: lecture/discussion, project method, concept mapping, use of analogies, topic study and dramatization.

2.2.6 Skills in Science

Skills are a set of broadly transferable abilities and potentials appropriate to science discipline and reflective of true behaviour of scientist used in science (Okeke, et al, 2004). Therefore the need for students to develop pratical skills through the process of problem solving in suitable environment is emphasized by science educators (Okeke et al, 2004). The development of these skills is basic to scientific inquiry and the development of intellectual skills needed to learn concepts (Ehikhamenor, 2012). Okeke (2004) and Ehikhamenor (2012) also

believed that the process skills can increase students' capabilities to answer questions and solve problems. This study is also concerned with measuring students' acquisition of practical skills in Biology which include manipulative, observational, communication and cognitive skills.

Manipulative skills involve proper handling of apparatus, setting up of experiment as well as the preparation of instructional materials. Assessment on manipulative skills is based on direct observation of students when they are doing their laboratory work. Observational skills involve students' ability to observe what takes place during practical investigation. Communication skills are essential skills which involve students' ability to represent findings of practical work in a logical manner with correct illustrations; cognitive skills also measure the understanding of the theoretical aspect of Biology in a practical test.

Practical skills in Biology are indispensable variables for students in the life sciences (Jones et al, 2007). Practical activities in Biology provide opportunities for students to actually do science as opposed to learning about science. All over the world, hands-on practical work is seen as a vital part of school science- just as speaking and discussion is a vital part of learning languages. An essential feature of modern schools in developed countries is an equipped laboratory so that all pupils can learn from practice as well as theory, (John Holman 2013)

Practical science motivates and awakens pupils' curiosity, but that is not the only reason it is important. Experiments help pupils understand theory by experiencing at first hand phenomena such as magnetism, acidity and cell division. It gives them skills and abilities that employers and universities value and can build on. Practical work is a vital and often under-valued element of science curriculum (John Holman, 2013). Universities and employers want their new recruits to be more accomplished in the laboratory. Practical science is an important means of supporting and extending the learning of all students in a class. Also, practical work is often enjoyable as it helps keep students interested and motivated. Hence, it is an important part of the curriculum for all students.

Just as it is not possible for anybody to study music without touching an instrument, history without consulting any documents, geology without leaving the classroom, another language without holding a conversation or even painting (whether fine art or interior decoration) without lifting a paintbrush, so it is not possible for any good scientist not to do practical work. While considering the advantages of practical work, Professor Ken Grattan (2012, p. 52), the Dean of Graduate Studies at City University said and I quote, ‘‘There are job vacancies for the right people with the right skills and that acquisition of skills makes the difference between being employable and not being employable.”

Akolade (2013) asserted that practical activities are needed to make the task of a teacher (which is teaching more) real to the students as opposed to abstract or theoretical presentation of facts, principles and concepts of subject matters. The development of these skills is basic to scientific inquiry and the development of intellectual skills needed to learn concepts (Ibe and Madyabum, 2001). Ibe and Madyabum also believed that the process skills can increase students’ capabilities to answer questions and solve problems. Raimi and Fabiyi (2008) and Bello and Abimbola (2007) observed that science teachers cannot effectively teach science without the use of the process of science; neither can the students learn science outside the application of the process. This implies that acquiring scientific knowledge should not be separated from the acquisition of science practical skills.

The need to assist students develop practical skills is a crucial aspect of Biology teaching as this helps students to carry out laboratory activities in a meaningful way as authentic scientists. However, secondary school teachers pay very little attention to practical activities that can lead to the development of practical skills (Adegoke, 2003). Raimi and Fabiyi (2008) also observed that not much research has been carried out on students’ acquisition of practical skills.

This implies that students do not possess sufficient practical skills that can aid their problem solving skills. This might have been caused by the instructional strategies used in teaching and learning Biology which do not promote the

development of practical skills. This therefore suggests that a self-activity based teaching strategy which facilitates student' participation and active involvement in the learning process would be a viable option for addressing problems associated with students' lack of practical skills in Biology. This is what this study seeks to address. Science process skills are the mental and physical abilities and processing strategies that scientists use in conducting scientific inquires. The American Association for the Advancement of Science (AAAS) identified fifteen of these skills as presented by Akereja (2011).

These skills are

i. Observation
ii. Measuring
iii. Classification
iv. Experimenting / Manipulating of Apparatus
v. Communication / Recording
vi. Predicting
vii. Inferring
viii. Counting / Numbering
ix. Using space / time relationship
x. Questionnaire
xi. Controlling variables
xii. Hypothesizing
xiii. Defining operationally
xiv. Formulating models
xv. Interpreting data
xvi Labeling

Due to the fact that the focus of the researcher is in the area of practical, the practical skills were tested. They are: observation, recording, drawing, labeling, manipulation of apparatus and classification. These skills were selected on the basis that these are the specific areas where the WAEC Chief Examiners in

Biology have reported that students do have problems. They (the examiners) have therefore suggested that because of the poor skills demonstrated by the students, there is a need for Biology teachers to help students develop these skills by teaching them better (May/June, 2007 WASSCE Report, Page 181)

2.2.7 Gender in Science

Gender and science education is a vital issue; gender interacts, in significant ways, with other social variables and must be taken into consideration (Babayemi 2014; Ramez, 2011; Huitt, 2007; Atwater, 2004). Research on the biological explanation of gaps in performance suggested that differences in brain structure, hormone production, and/or maturation rates may account for girls' greater advantage in school-related tasks. Research showed that the parts of the brain responsible for processing verbal information and permitting the exchange of information between hemispheres were more highly developed in girls (Ogundare, 2008; Ogundare et al, 2008).

Girls also demonstrated earlier development in the brain regions responsible for impulse control, and in general, it matured in girls earlier than boys (Ogundare, 2008). However, the extent to which these biological differences manifested themselves in behavioural differences with implications for teaching practices was unknown. The assertion that gender influence is effective on science achievement dates back to very old times, and this may be because of women's missing role in science in the past. However, this assertion is proposed with findings of many studies that males do better in science courses than females (Temizkan, 2003).

Okeke (2007) in her inaugural lecture on **Gender stereotyping in Science education**, delivered in the Department of Science Education, University of Nigeria, Nsukka, wrote and I quote: "A lot has been said and written on the subject of gender. Indeed, literature abounds on gender as a major factor in science and technology all over the world. I will just mention a few, (Okeke 1987, 1990, 2002); Mulemw; (1991); Harding & McGregor (1996). Gender is a broad

analytical concept which draws out women's roles and responsibilities in relation to those of men. **Gender** refers to the socially/culturally constructed characteristics and roles which are ascribed to males and females in any society. Males are assigned such attributes as bold, aggressive, logical in reasoning, intelligent, self confident, dominating/assertive, tactful, economical in use of words, etc. Females are assigned the opposite attributes such as fearful, timid, gentle and illogical in reasoning, dull, passive, submissive, tactless and talkative. To verify the truth in these assignments, we need to answer some relevant questions such as: Does every male in any society possess the characteristics assigned to males and vice versa? Are males and females born with those characteristics? In other words, are those characteristics genetically determined? The correct answer to each question is emphatic NO! Surely, some men possess some of the characteristics ascribed to the females and vice versa''.

2.2.8 Mental Ability in Science

Mental ability has been found to influence performance of students in Biology (Olagunju and Chukwuka 2008; Raimi, 2003; Salami, 2002). The global objective guiding the consideration of mental ability is that the test has the capacity to discriminate between high and low ability participants (Ehikhamenor, 2012; Adekunle, 2005). Caroll (2006) found that the relationship between certain capabilities of mental ability measured by academic performance of learners and intelligence test is significant. Furthermore, Caroll, (2002) found that the performance needed on a number of mental ability tests such as, ability to apply knowledge in solving problems, ability to manipulate abstract concepts and relationships and test of language competence are linked to performance in school learning. Besides, measurement of cognitive skills is a measure of mental ability of students (Cohen, 2013)

General mental ability is a substantively significant determinant of individual differences in academic performance. Modern research on general intelligence has sharpened validity generalizations aimed at forecasting

educational outcomes, occupational training and work performance (Babayemi, 2014). Besides, measurement of cognitive skills is a measure of mental ability of the students. Similarly, Adeoye (2011) asserted that knowing the intelligence level of learners will to a large extent; determine how much the learner will achieve from a learning process or skill programme.

Against this background, mental ability is included as a variable in this study. Studies have revealed that students have varying ability levels which tend to affect learning outcomes (Olagunju et al, 2008; Raimi, 2003). Studies have also shown that students of varying ability levels perform differently depending on the types of methods and materials used for instruction, (Okafor 2009). It is hoped that the problem solving, instructional strategies formulated for this study will be applicable to students' learning irrespective of their varying capabilities.

2.3 Empirical Review

2.3.1 Experiential Learning and Students' Achievement in Biology

The application of instructional strategies to science teaching and programs holds promise for improving students' achievement and interest in science (Jegede, 2012). Many strategies have been successfully used to improve students' achievement in sciences; however, the level of learning achieved by a learner is one of the most important factors which indicate the success of a learning environment. In order to ensure the effectiveness of teaching environments, it is important to take account of characteristics, abilities and experience of learners as individuals or as a group when beginning to plan a learning environment (Linver et al, 2012).

Experiential learning activities have been developed to foster students' achievement in science. Research conducted by Krapp (2002) revealed that students benefit through experiential learning in their science classes when they are motivated to contribute to their group; when they learn cooperation skills and through enhanced self –esteem, more than using any other method that will not

involve the learners in the teaching –learning affair. Kolb *et al* (2008) in their research work revealed that the more open –ended and non formulaic an assignment is, the more likely students will rely on their own experience and reflection and immerse themselves in the topic. This means that learning by self-experience leads unlimited achievement in any course of study and more particularly in science, of which Biology is one. Sjoberg (2002) established in his work that more frequent use of experiential learning strategy during science lessons was significantly correlated with higher students' achievement in science.

2.3.2 Experiential Learning and Students' Attitude to Biology.

One key strategy for improving the general attitude of students to science in general and Biology in particular is the use of experiential learning. That part of teaching that makes science or biology lesson meaningful is the provision of experience that will boost active participation of the learners and thereby improve their attitude to it (Biology) (Kristi, Erin and Micheal, 2009). In addition, the use of experiential learning materials during an oceanography course produced significant learning gains and enhanced student attitude (Kolb and Kolb, 2005).

Experiential learning stands to improve the learner's attitude toward the learning of sciences like Biology and that is the reason why Daramola (2007), opined that high quality learning occurs when the learner is ready –cognitively, emotionally –to meet the demands of the learning tasks. Attitude, as it has been observed is a facilitating factor necessary for learning by the student because it gives a positive relationship with the teacher's instructional materials and his method of instruction (Awolere, 2006). Ogunleye *et al* (2011, p. 454) in their studies agreed that "science lesson can be made more meaningful with the use of concrete object/materials than mere abstraction using chalk and talk by the teachers". In short, they see the job of impacting knowledge to learners in conjuction with other things –physical materials, generated experience etc. With positive attitude of student to the teaching of science, students also develop their manipulative skills. (Eyitayo, 2011)

2.3.3 Experiential Learning and Students' Practical Skills in Biology

Activities have traditionally played an important role in Science Education Programmes hence should be intricately woven into the fabric of science instruction in schools. Science instruction in Nigerian high schools traditionally focuses on teaching subject-matter content in specific courses such as Physics, Chemistry, and Biology (Raheem et al, 2002). Students' acquisition of such content-based information is most frequently assessed through the use of paper-and-pen tests consisting mainly of multiple-choice, short answer and essay tasks. Experience is an essential ingredient if knowledge will be created. Likewise, there cannot be any meaningful acquisition of skills if experience is taken out. Experiential learning engages the learner at a more personal level by addressing the needs and wants of the individual; it employs the whole learning wheel, from goal setting to experimenting and observing to reviewing and finally action planning.

This complete process allows one to learn new skills, new ways of thinking and science process skills (Babayemi, 2014; Adeoye, 2011). Practical activities should engage the students in hands-on, mind-on activities, using varieties of instructional materials/equipment to achieve teaching objectives. Nwagbo (2008: 41) stated that: 'The use of practical activities (approach) in the teaching of biological concepts should therefore be a rule rather than an option to biology teachers, if we hope to produce students that would be able to acquire the necessary knowledge, skills and competence needed to meet the scientific and technological demands of the nation'.

2.3.4 Generative Learning and Students' Achievement in Biology.

The study by Grabowski et al of Pennsylvania State University (2003, p. 145) shows that "Only through learners' generation of relationships and meaning themselves can knowledge be generated that is sustainable". This is the essential process of meaning making by the learner. A variety of studies reporting on results of generative learning have shown that in most cases, active learner-involvement

produced increased gains in recall and higher order thinking or improvement in self-regulated learning skills i.e. improved achievement in all areas (Lee, 2008).

Lee (2008) reveals that when students/learners are allowed to selectively attend to events and to actually create relationships and meaning from events, there would be increased improvement in their achievement. The level of learning achieved by a learner is one of the most important factors which indicate the success of a learning environment (Tyler, 1949).

2.3.5 Generative Learning and Students' Attitude to Biology

It has been revealed in studies that intervening variables such as motivation, attitude, anxiety, and socio– economic status and so on could determine to some extent the rate at which the learners learn in any classroom teaching – learning situation (Gray, 2011; Jone et al, 2007; Chacko 2001). It is in the interest of the society, and the responsibility of educators to improve students' attitude toward science (Biology inclusive) and to prepare students to live in a highly scientific and technological society. The future of our society will be understood and this will help shape the complex influence of science on our world (Ungar, 2010). Generative learning strategy is one major strategy to help the learners improve their cold and warm attitude towards Biology in particular and science in general.

Introductory science courses such as Biology, Chemistry and Earth science are usually required in our learning institutions in order to improve the general attitudes of learners toward science (Faralinaz, 2012). In other to make these science courses meaningfully taught, there is a need for the learners to be allowed to generate meanings from events. In generative learning strategy, learners have facts to give, expressions to make, and should therefore be given opportunity and freedom to express their minds and give their personal opinions about the subject matter being discussed. The instructor here just has to accept the feeling of his students, appreciate the contribution of the learners, and acknowledge and guide the ideas of the students. He also guides factual information by asking the students stimulating questions that can enhance their (students) participation.

2.3.6 Generative Learning and Students' Practical Skills in Biology

When pursuing a course in biology, students acquire in–depth, subject–specific knowledge of biological systems and concepts. The students in addition also develop a range of practical and technical skills from laboratory sessions and learn how to use specialist techniques and technical equipment. Students learn how to confidently handle masses of diverse data and to draw conclusions.

Students also develop more general skills. Report writing and presentations also boost communication skills, while seminars and projects develop team-work skills. Other skills developed are organizational skills, self –enhanced initiative, business awareness and strong interpersonal skills. Generative learning strategies stand to boost all the enumerated skills in Biology (Viadero, 2006; Kimura, 2005).

2.3.7 Modified Conventional Strategy and Students' Learning Outcomes

This is the oldest method of teaching used in most Nigerian schools. It is a traditional 'talk-chalk strategy. The teacher "gives out" the facts to the students and the students in turn listen and digest the knowledge (Osokoya, 2002).

There are reasons listed by Adesoji, (2004) which make teachers refuse to change their conventional teaching style:

(a) Lack of infrastructural facilities

(b) Overloaded curriculum

(c) Lack of training programmes/workshops and

(d) Lack of skill in handling difficult concepts identified by Olagunju, 2002

This study considered the use of Critical Thinking Motivation strategies (Pre-Theoretic Intuition Quiz and Puzzle-Based learning) which have been found to help students take charge of their learning (meta-cognition) and so become independent learners.

2.3.8 Gender and Students' Learning Outcomes.

Work on the roles of sex and students' achievement has shown that the roles of individual sex seem to be relevant factor to be associated with school achievement. Fadoju (2001) pointed out that the inability to cope with the problems of living in the society that sees the female as a second class citizen provides a good ground for psychological disorders. The factors causing psychological disorder evolve from different human experiences that could be biological, environmental, interpersonal relationship, psychological function, role conflict and personal values (Ogundiwin, 2013).

Many studies conducted by many scholars concluded that males do better in science course than their female counterparts (Lee *et al*, 2007 and Temizkan, 2003). Gender influence on academic achievement and skills acquisition has generated much concern among researchers. There has been a mixed result for gender performance on students' achievements and practical skills acquisition, with boys demonstrating higher ability skills in some tests (Ehikhamenor, 2012); and girl performing better than boys in practical skills (Bilesanmi – Awoderu, 2002). However, Oduwaiye (2009) found no gender related difference in students' achievement while Mukunthan (2011) similarly found no gender difference in acquisition of practical skills.

The implication of these studies is that there is no definite conclusion as to whether males or females are better achievers in performance and in the acquisition of practical skills. Therefore, this lack of consensus on the influence of gender on learning outcomes makes the need for further investigation imperative. Initially, studies about gender effect on science achievement mostly tried to explain it with biological differences (different functioning of males' and females' brains). However, now, it has been shown that cultural and social effects are more responsible for making gender a factor for science achievement (Jegede, 2007).

The critical believe of biological theorists is that gender difference are natural and therefore unalterable (Olubunmi, 2001). It would be right and proper

to treat boys and girls in school differently because of their natural inclinations to different roles. On gender study, Okeke (2007) in his review of studies concludes that gender differences exist in students' achievement in science and any other subjects. Osborne, *et al.*, (2003) further said that another main reason for such difference in performance is noted in the attitude of each gender. However, numerous studies have shown that boys have a consistently more positive attitude to school science than girls, although this effect is stronger in Physics than in Biology; girls' attitudes to science are significantly less positive than boys (Osborne, *et al.*, 2003). It was also confirmed in the study by Soltani *et al.*, (2010) that there was no significant difference between girls and boys on attitude towards Biology.

The study conducted by Bello *et al.*, (2007) revealed that a significant difference does not exist between the achievement in evolution of male and female students generally, when taught through a particular teaching strategy. Many studies have shown that girls perform better in school than boys in all major subjects (Ogundare, 2008).

Some studies indicated that gender differences generally are small or non-existent. Typical example is that of Sjoberg (2006), who found that in science, boys outperformed girls, but in reading and writing, girls have the advantage. A study examined the fifth and sixth grade students that enrolled in a science class and revealed no gender differences in students standardized test scores. Ogunleye *et al.*, (2011) studied gender differences within ethnic groups of varying ages and revealed more similarities than differences. On most measures, gender differences did not vary much from one ethnic group to another. Grant and Branch (2005) showed that;

I. females scored higher than males in reading and writing across all ethnic and age groups,

II. there was no gender gap for any group of 8^{th} and 9^{th} graders in Math achievement, and

III. twelfth grade Hispanic females outscored Hispanic males in Social studies' achievement.

Ehikhamenor (2012) and Ogundare (2008) showed evidence of a growing gender gap in educational achievement in a number of developed countries. Educational statistics have indicated that females are outperforming males at all levels of the school system, attaining more school and post –school qualifications and attending University in higher numbers (Lee et al, 2008; Raimi et al, 2002).

Gender–biased classroom practices have been shown to negatively impact the performance of females in sciences during science instruction; teachers may inadvertently be sending the message that female students are less capable in these areas (Daramola, 2007; Wendy, 2004). In recommendation, more studies on gender differences in academic achievement are needed to make conclusive implications of the impact that gender may have on students' academic achievement.

2.3.9 Mental Ability and Students' Learning Outcomes.

The effect of mental ability is a factor that should be of concern to any science educator researcher; more especially in a study like this. General ability is a term used to describe the level at which an individual learns, understands instructions and solves problems. General mental ability has been found as the single best predictor of the extent of academic performance/achievement of students. Studies have found that students with higher general mental ability acquire more academic knowledge and faster than others. Higher levels of academic knowledge lead to better performance.

Also, study by Adekunle (2005) asserted that knowing the intelligence level of learners will, to a large extent, determine how much the learner will achieve from a learning process or skills programme. As a result of all these, mental ability is included as a variable in this study. It is likely that the problem solving instructional strategies to be used in this study will be applicable to students' learning irrespective of their varying learning capabilities.

2.4 Importance of Science Teaching

It is important and needful to stress the significance of science teaching in a study like this, by stating its aims. Some of the importance of Science Teaching, according to Jay (2012, pp. 1&2) include the following :

- Science is taught in Schools because general education is not complete without it. In Schools, Science is taught to acquaint pupils with natural phenomena in their environment.
- The aim of introducing Science in Schools is not to produce scientists, but to impart liberal education.
- To acquaint pupils with the broad outline of great scientific principles and the ways in which these are exemplified and applied in the service of man.
- The objective of science learning is to prepare children to earn a living. They (students) are cleverer and more intelligent ; they eventuallly become doctors, agricultural officers, engineers, etc. with their determined goal of life.
- Science teaching aims at helping children even in their ordinary life to use the gifts of science everyday.
- The aim of science teaching is to make the pupils wonder about things and to make them ask questions out of curiosity. That is because, a man who knows nothing about the discoveries of chemistry, physics and biology in the last three hundred years cannot be properly called an educated man.
- In science teaching, the teachers' attitudes towards the wonders of sciences are important in as much as pupils copy their teachers in attitude development.
- While these facts of science are important, it is also important that pupils should understand the system of observation, guess and experiment, which is known as scientific method. So, one of the aims of science teaching is to explain this method and to help pupils to think correctly about science in relation to other subjects of learning.

- ❖ The teaching of science aims at helping pupils to live in the modern world, to introduce them to the methods and systems of science and to develop some important attitude.
- ❖ Learning of science has a value as character training. It develops a habit of thinking, feeling and acting, a mixture of curiosity and caution students. Curiosity leads to correct observations and caution prompts pupils to objectively say, "I do not know."

The above aims of science education in schools can be achieved by its combined teaching in the classroom and the laboratory.

2.5 Appraisal of literature

Many studies have been conducted both at national and international levels on the use of many instructional strategies to improve the achievement of students in Biology. Ogunleye *et al.*, (2011) studied how generative instructional strategy enhanced senior school students' achievement but in Physics. Bello *et al.*, (2007) investigated gender influence on achievement of students in Evolution. Jolaosho (2012) and Grabowski (2004) examined the effect of experiential learning strategy on students' achievement in and attitude to Physics and interest in science.

Empirical studies in the use of experiential learning and generative learning in the teaching of Biology are very few. The two strategies have been used separately and in different subjects. None of the earlier researchers investigated the combined effects of the two strategies (Experiential and Generative) on Biology. Few studies have been carried out with the interactive effect of gender, mental ability and attitude on the academic achievement of students in Biology. Due to this gap, this study investigated the effects of both experiential and generative learning strategies on students' academic achievement in, attitude to and practical skills in Biology in Oyo State, Nigeria.

2.4.1 The present study

The present study is concerned with the effect of experiential and generative learning strategies on students' academic achievement, attitude to and Practical skills in Biology in Oyo State, Nigeria. Many studies have been carried out on similar topic both at the national and international levels, on the use of the instructional strategies to improve students' achievement. Works were carried out on each of the two strategies separately and on different subjects, however, not much has been done using these two strategies together in the area of Biology.

CHAPTER THREE

METHODOLOGY

3.1 Research design

The research design adopted for this study was the pretest-posttest, control group quasi experimental design to determine the effect of experiential and generative learning strategies on students' academic achievement, attitude to and practical skills in Biology in Oke-Ogun, Oyo state, Nigeria.

The research design was represented below using symbols

0_1 X_1 0_4 E_1 - Experimental Group 1

0_2 X_2 0_5 E_2 - Experimental Group 2

0_3 X_3 0_6 C - Modified Conventional Group

Where

0_1 0_2 0_3 = Pretest scores of the experimental 1 & 2; and control groups respectively

0_4 0_5 0_6 = Posttest scores of the experimental 1& 2; and control groups respectively

E_1 E_2 =The Experimental Groups 1& 2; C = Control group,

X_1= Experiential Learning Strategy (ELS);X_2 = Generative Learning Strategy (GLS); X_3 = Modified Conventional Strategy (MCS)

The study adapted 3x2x3 factorial matrix which showed treatment at 3 levels (two experimental and one control), gender at two levels (male and female), and mental ability at 3 levels (high, medium, and low) as represented below:

Table 3.1: 3x2x3 Factorial Matrix of the Study

Treatment	Mental Ability	Gender	
		Male	Female
Experiential Learning Strategy	High		
	Medium		
	Low		
Generative Learning Strategy	High		
	Medium		
	Low		
Modified Conventional Strategy	High		
	Medium		
	Low		

Diagrammatic Representation of the Variables

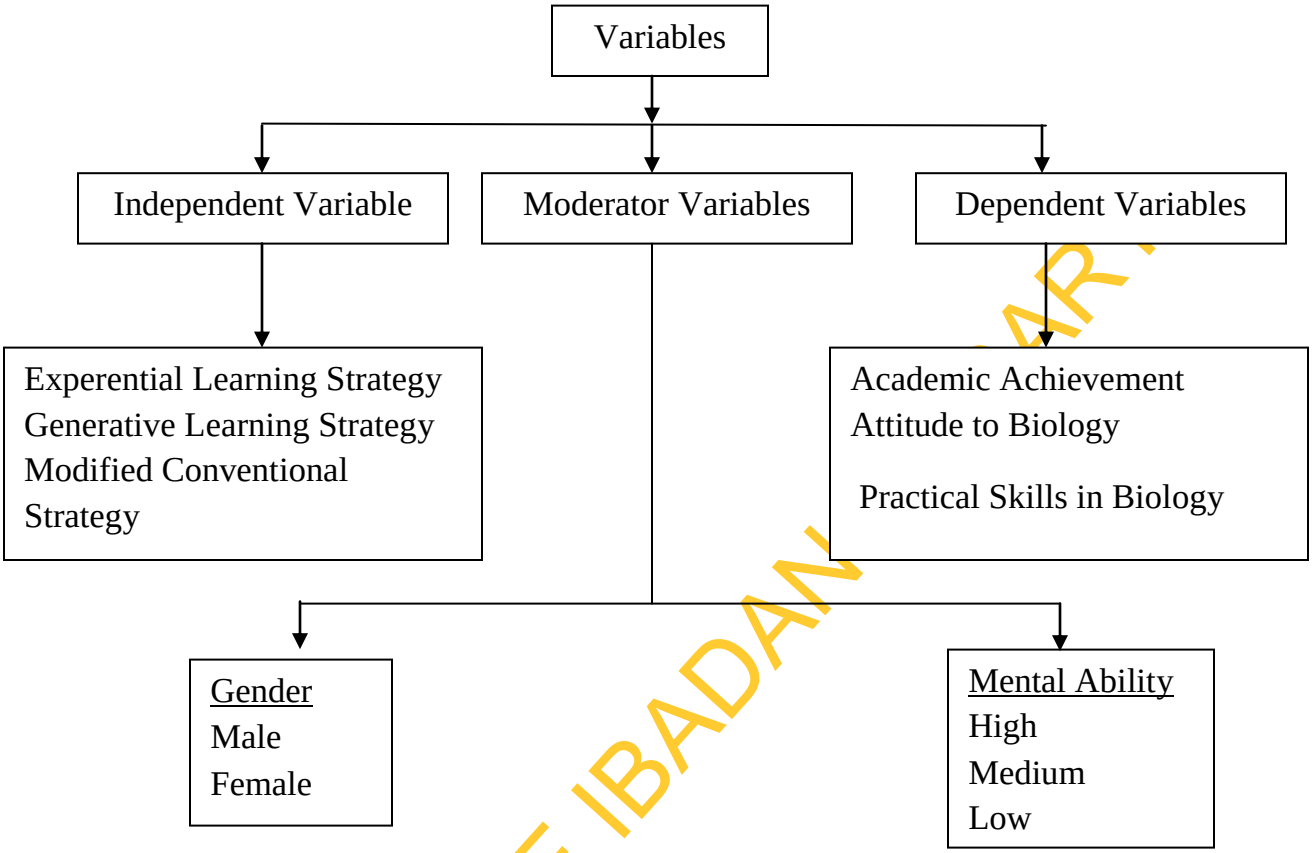

Figure 3: Diagrammatic Representation of the Variables

3.2 Variables of the study

a. Independent variable: This is instructional strategy manipulated at 3 levels

1. Experiential Learning Strategy
2. Generative Learning Strategy
3. Modified Conventional Strategy

b. Moderator Variables: These are

1. Gender at two levels: male and female;
2. Mental ability at three levels: high, medium, and low

c. Dependent variables: These are students'

1. Academic achievement in Biology,
2. Attitude to Biology, and
3. Practical Skills in Biology.

3.3 Selection of Participants

Oyo state is divided into three senatorial districts – Oyo North, Oyo South and Oyo central. Of the three, Oyo North was randomly selected and was used. Oyo North is further divided into three federal constituencies. Out of the three, Iseyin – Itesiwaju – Kajola – Iwajowa Federal constituency was randomly selected through balloting, and nine secondary schools were purposefully selected from all secondary schools in each Local Government Area. The schools involved in the study were selected based on the availability of Biology Teacher(s). Students from intact classes were involved. One intact class per school was involved in the study. There were two experimental and one control groups in each school. The SS I students (participants) involved in the study were four hundred and twenty eight (428). They were made up of 197 males and 231 females.

3.4 Research Instruments

The following instruments were used for the study.

i. Biology Achievement Test (BAT)

ii. Questionnaire on Attitude to Biology (QAB)

iii. Biology Practical Skills Rating Scale (BPSRS)

iv. Instructional Guide on Experiential Learning Strategy (IGELS)

v. Instructional Guide on Generative Learning Strategy (IGGLS)

vi. Instructional Guide on Modified Conventional Strategy (IGMCS)

vii. Mental Ability Test (MAT)

viii. Evaluation Sheet for Assessing Teachers (ESAT)

3.4.1 Biology Achievement Test (BAT) and its Validation

BAT was designed to measure students' performance in specific academic areas in Biology. The instrument as shown in appendix I was in two sections - A and B. Section A has to do with the personal data of the respondents while section B elicited response from the students. The test was made up of forty five items that covered topics in the senior secondary school syllabus, particularly the concepts examined. Forty five items were reduced to thirty six by educational experts and experts in the field of science education, while validation after trial – testing reduced it to twenty five. The table of specification for SBAT is shown Table 3.2

Table 3.2: Table of specification for BAT

Topic/ Concept	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Total
Pollution	2(1,9)	2(2,4)	2(3,5)	2(11,13)	1(8)	2(6,7)	11
Ecology	-	1(16)	1(10)	-	-	1(12)	3
Conservation of natural resources	2(17,21)	1(18)	1(19)	-	1(15)	1(14)	6
Population	1(25)	2(20,23)	1(24)	1(22)	-	-	5
Total	5	6	5	3	2	4	25

Forty five items – multiple choice objective test was scrutinized by the researcher's supervisor, teachers, and educational experts for content validity. The items were then reduced to thirty six. The instrument with the thirty six items was trial-tested on thirty students outside the study area, making use of discimation indices of 0.4-0.6. The items that ranked below 0.4 represented those that were too cheap while those above 0.6 were those that were too difficult. Based on this difficulty level, the surviving items were twenty – five as shown in the Table 3.2. Kuder – Richardson formula 20 was used to calculate the reliability of the test. The value obtained was 0.74.

3.4.2 Questionnaire on Attitude to Biology (QAB) and its Validation

QAB is an attitudinal questionnaire developed by the researcher and aimed at assessing students' attitude to biology. The instrument was divided into two sections- A and B and was presented in appendixes IIA and IIB. Section A contained the personal data of the respondent while section B contained twenty-seven open ended items. Each item wss placed on a four point Likert type ordinal scale of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). The scoring was from 4, 3, 2, to 1 for positively worded items and 1, 2, 3 to 4 for negatively worded questions. The number of the items was reduced later after trial-testing; validation reduced it to twenty.

For face and content validity, the instrument containing twenty seven items initially was given to experts in Biology education and more particularly Biology teachers. Copies were also given to English teachers and finally my supervisor so as to make necessary correction and ascertain its effectiveness for the study. After the expert assessment, some items were removed while some were modified. This assessment exercise reduced the items to twenty five which were used for trial-testing on thirty students in a pilot school. After validation, the items were eventually reduced to twenty. Crombach alpha co-efficient of 0.82 was obtained. Therefore, the instrument was considered valid enough to be used for the study.

3.4.3 Biology Practical Skills Rating Scale (BPSRS) and its Validation

The Biology Practical Skills Rating Scale (BPSRS) was designed to access students' practical task based on direct observation during their laboratory work. The Biology Practical Skills Rating Scale (BPSRS) was used to determine students' ability to manipulate, observe, record, label, classify and draw in the practical class. A copy of the instrument was shown in appendix III.

This instrument was in two sections – A and B. Section A has to do with the personal data of the respondents while section B rated the students' practical skills in Biology. The skills rated were: observation, recording, labeling, drawing, classification and manipulation.

Section B was a six-point continuum that ranged from zero for total inability to exhibit the skills, to five at the extreme for full exhibition of the skills.

The instrument was used and scored by three independent raters and the inter-rater reliability was estimated using Scott π. The inter-rater reliability index obtained was 0.75.

3.4.4 Instructional Guide on Experiential Learning Strategy (IGELS) and its Validation.

The instructional guide was adopted from Kolb's (1984) experiential learning model and was used for the teaching of treatment group one. Learners worked in groups of five. In the guide, there was information to the teacher who was one of the research assistants. The instructional guide provided an opportunity for the learners to play active roles and be at the centre of the learning process. There were four procedural steps which include:

1. Concrete experience

The facilitator provided learners the basis for the learning process ahead of them. He engaged the individual student and supplied all necessary materials to each of them. He exposed them to the concepts to learn. He introduced the processes and stepss of Experiential Learning to the learners.

2. Reflective observation

Students were asked to make sense of the experience. They were expected to recall information and ideas from their memories as well as experiences on the problem presented. Having exercised patience, and with objectivity, careful judgment and observation, learning was then expected to take place.

Learners were expected to write all these pieces of information and reflect on them.

3. Abstract conceptualization

Each student was involved in performing the activities. These included carrying out some field studies as well as performing some practical activities by following established procedural steps.

4. Active experimentation

Learners tested the theories so as to lead to new experiences. The facilitator guided the learners to provide correct answers to their misconceptions where applicable, to make predictions about the real world and then act on those predictions.

For validation, the instructional guide was presented to experts in Biology education and more particularly Biology teachers in secondary schools. Copies were given to English teachers and finally the researcher's supervisor so as to make necessary correction on the suitability of the content, language of presentation and the workability of the instructional strategy. The inter-rater reliability was then estimated using Scott's π and the inter-rater reliability index of 0.74 was obtained.

3.4.5 Instructional Guide on Generative Learning Strategy (IGGLS) and its Validation

The instructional guide was adopted from Osborn and Wittrock (1991) and was used for the teaching of treatment group two. In this group, learners worked in group of five. The instructional guide contained information to the research assistant who also doubled as the facilitator in the teaching-learning process

environment. The instructional guide provided opportunity for the learners to play active roles and to be at the centre of the learning process. It was made up of five procedural steps which included: the introductory, focusing, activity, discussion and the application phases.

Introductory Phase: The facilitator introduced learners to the task ahead of them. He/she then distributed them into different activity groups. He/she supplied all necessary materials to each group and assigned learners in each group specific tasks to be performed. He/she also exposed them to the concepts to be learnt. He/she familiarized learners with the processes and methods of Generative Learning Strategy.

Focusing Phase: The facilitator presented the problem area to learners. Learners were then expected to recall information and ideas from their memories as well as experiences on the problem presented. After this, every member of the group brainstormed and discussed the problem presented by the facilitator. All these pieces of information were expected to be written and mentioned verbally. The facilitator then went round to supervise but never to correct learners' misconceptions.

Activity Phase: Every learner in a group was involved in performing diverse activities. These included carrying out some demonstration as well as performing some practical activities by following some procedural steps provided by the facilitator.

Discussion Phase: Learners discussed the results of the activities performed in their respective groups. The facilitator guided learners to provide correct answer to their misconceptions where applicable. Summaries of results were made in each group.

Application Phase: Learners presented their summarized results to the whole class. Also, they were expected to apply the new knowledge acquired to other similar or related situation with the assistance of the facilitator.

For validation, this instructional guide was presented to experts in Biology education including two Biology teachers from Colleges of Education and Biology teachers from two secondary schools. Copies were also given to two English teachers and finally to the researcher's supervisor for necessary corrections on the suitability of content, language of presentation and the workability of the instructional strategy. Corrections were then effected based on the recommendations received. The guide was used by three independent raters and the inter-rater reliability was then estimated using Scott's π, with the inter-rater reliability index of 0.78.

3.4.6 Instructional Guide on Modified Conventional Strategy (IGMCS) and its Validation

The instrument was used for the control group. This teaching approach is commonly used in classroom teaching. It is a teacher-centered approach which focuses more on the teacher and his activities in the classroom. It was modified for the purpose of this study. Two questions were allowed in each class.The following steps were followed:

Step I: The teacher introduced the new concept by asking questions on relevant prior knowledge. The teacher did all the talking while the learners sat passively, facing the chalkboard.

Step II: The teacher stated the new topic.

Step III: The teacher explained the new concept as the learners listened to the teacher.

Step IV: The teacher asked questions on the concepts discussed.

Step V: The teacher gave the summary of the whole lesson on the chalkboard.

Steps VI: The teacher allowed the students to ask questions.

Step VII: The teacher concluded the lesson by marking learners' notes.

The instructional guide was presented to experts in Biology Education for corrections on the suitability of the content, language of presentation and the workability of the steps proposed. The reactions given were used to improve on

the draft instrument; and the inter-rater reliability was then estimated using Scott's π. The inter-rater reliability index obtained was 0.76.

3.4.7 Mental Ability Test (MAT) and its Validation.

Mental Ability Test was adopted from Australian Council for Educational Research (ACER) Test, (2012). The instrument was modified as shown in appendix VIIA and VIIB, to suit our culture here by replacing the foreign names of towns and people with our own. The instrument was in two parts- Mathematical and English. This test has the capacity to discriminate between high and low ability participants. The maximum score a student can obtain is 100. Students who score 60% and above were grouped into high mental group; 40% to 59% were assigned to medium ability group while students who obtained less than 40% were placed in low mental ability group. For the purpose of this study, the instrument was later adapted with the inclusion of names of people and objects based on our culture.

The instrument was validated using Alternate/Parallel forms of reliability. The test was validated to ascertain its suitability for the study. The alternate/ parallel forms of reliability gave the reliability index value of 0.86 which was considered valid and appropriate for the study.

3.4.8 Evaluation Sheet for Assessing Teachers (ESAT)

This instrument was adopted, adapted, and used to evaluate the research assistants on the effective use of the instructional guides during the teaching process. The instrument revealed their presentation of concepts, mastery of the topics, use of materials and directed activities, and how effective their presentations were for the mastery of the concepts by the students.The instrument was used to evaluate the performance of the research assistants on the effective use of the three strategies:

1. Experimental Learning Strategy
2. Generative Learning Strategy
3. Modified Conventional Strategy

3.5 Research Procedure

Work Schedule

3.5.1 Weeks 1 and 2 were used for the training of Research Assistants.

3.5.2 Week 3 was used for the administration of Pre- test

3.5.3 Weeks 4 –11 were used for the treatment

3.5.4 Week 12 was used for the administration of Post –test

3.5.1 Training of Research Assistants

The training of the research assistants was done to provide step by step explanation of the teaching guides as seen in appendixes IV, V and VI. After the training, the research assistants were assessed using the evaluation guide as seen in appendix VIII. This process took two weeks. Two research assistants per school were involved, so as to take care of the skills in practical Biology.

3.5.2 Administration of Pre-test

One week was used for the administration of the pre-test using the outlined instruments:

i. Mental Ability Test (MAT)

ii. Students' Attitude to Biology (QAB)

iii. Biology Achievement Test (BAT)

iv Biology Practical Skills Rating Scale (BPSRS)

3.5.3 Treatment

The study involved two treatments and one control groups. Each of the groups consisted of male and female students of varing mental abilities, (high, medium and low). Each group was exposed to one of the instructional strategies outlined below:

i Experimental group 1: Experiential Learning Strategy

ii Experimental group 2: Generative Learning Strategy

iii Contro group: Modified Conventional Strategy

A. Procedure for experimental Group 1 (Appendix V)

Steps involved in Experiential Learning.

Step I: Introduction and grouping of students.

The teacher introduced the lesson and divided the students into specific groups for activities

Step II: Concrete experience: Presentation of materials:

Students followed instructions as the teacher presented materials to work with e.g. a cock and a cockroach

Step III: Reflective observation:

Students relayed their previous experience on each concept/topic.

Step IV: Abstract conceptualization:

Students were exposed to new learning or experience through e.g. measurements, observation, manipulation of apparatus etc.

Step V: Active experience

Students asked question based on the differences and similarities between their previous and their new experiences e.g. is it true that it is cockroach that does give birth to bed bug?

Step VI: Conclusion and application

The students were guided to provide correct answers to the questions raised.

Step VII: Summary: Students copied/wrote notes; the teacher inspected, then marked their notes.

B. Procedure for experimental Group 2 (Appendix VI)

Steps involved in Generative Learning

Step I: Introductory Phase: (Introduction and grouping of students):

The teacher put the students into small groups for activities.

Step II: Focusing Phase:

Students followed instructions as the teacher presented materials to work with e.g. a cock and a cockroach

Step III: Activity phase: Students manipulated apparatus as each group was given different materials on each topic, each week

Step IV: Discussion period:

Students asked questions based on their observations & record.

Step V: Application phase:

Students generated knowledge from observation. This was to be done on group basis.

Step VI: Conclusion:

A representative from each group presented new knowledge to the entire class.

Step VII: Summary: Group differences among the students opinion were reconciled.

C Steps Involved in Modified Conventional Strategy (Appendix IV)

In this group the following steps were followed.

Step I: Introduction of the new concept:

The teacher introduced the new concept by asking questions on relevant prior knowledge. The teacher did all the talking while the learners sat passively, facing the chalkboard.

Step II: Presentation of the lesson:

The teacher taught the new concept as the learners listened to the teacher.

Step III: Formative evaluation stage:

The teacher asked questions on the concepts discussed.

Step V: Summary: The teacher gave the summary of the whole lesson on the chalkboard and allowed the students to copy the summary.

Step VI Conclusion:

The teacher concluded the lesson by marking learners' notes.

Step VI Application phase:

The students were guided to make necessary applications from the lesson taught.

Step VII: Assignment:

The teacher gave the students homework/assignment.

3.5.4 Administration of Post – test

Posttest was administered to all the groups (i.e. both experimental groups and the control group) at the completion of treatments. The same instruments used for pre-test (except Mental Ability Test (MAT) were used as post-tests. The instruments are Biology Achievement Test (BAT), followed by Questionnaire on Attitude to Biology (QAB) and Biology Practical Skills Rating Scale (BPSRS). The posttests lasted for one week, which was the twelfth week of the study.

3.6 Methods of data analysis

The quantitative data was collated, coded and analyzed using Analysis of Covariance (ANCOVA). This was to determine group differences, using the pre-test scores as covariates. Estimated Marginal Mean (EMM) was used to find the magnitude of the differences in the various groups where there was significance effect. To determine the actual source of the significant differences, Scheffe Post hoc test was performed on the mean scores of the groups. All the set hypotheses were tested at $P< 0.05$ level of significance.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Introduction

This study investigated the effects of Experiential and Generative Learning Strategies on students' academic achievement, attitude to and practical skills in selected concepts in Biology in Oke-Ogun part of Oyo state, Nigeria. Gender and Mental ability were also considered as the moderator variables.

4.1 Descriptive Statistics.

4.1.1 Descriptive Statistics Associated with Treatment

Table 4.1: Summary of Descriptive Statistics Associated with Treatment

Table 4.1 displays the mean scores of the students' achievement, attitude and practical skills scores.

	Achievement Scores			**Attitude scores**			**Practical skills scores**		
	ELS	GLS	MCS	ELS	GLS	MCS	ELS	GLS	MCS
Number of cases	146	141	142	146	141	142	146	141	142
Pre-test mean	16.97	15.85	10.03	26.06	28.53	42.79	11.49	13.92	17.20
Pre-test S.D	2.92	3.99	3.28	3.11	3.68	3.36	2.05	3.34	3.18
Posttest mean	20.14	17.69	9.59	33.75	33.59	36.63	22.56	19.66	9.58
Posttest S.D	4.17	4.54	5.00	2.01	2.16	2.39	1.99	2.15	2. 42
Mean Gain	3.17	1.84	-0.44	7.69	5.06	-0.16	11.07	5.74	-7.62

- ELS - Experiential Learning's strategy
- GLS - Generative Learning Strategy
- MCS - Modified Conventional strategy.
- S.D- Standard deviation

From data in table 4.1, the post test scores improved for experiential learning strategy in achievement, attitude and practical skills scores by 3.17, 10.57 and 11.07 respectively. Generative Learning Strategy; post test scores shows improvement for Achievement, Attitude and Practical skills by 1.84, 5.22 and 5.74 respectively. In the case of Modified conventional strategy, the posttest scores did not improve in achievement, attitude and practical skills scores. The mean gain in descending order is: Experiential Learning Strategy had higher mean gain than Generative Learning Strategy, while Generative Learning Strategy had higher mean than Modified Conventional Strategy.

Figures 4.1, 4.2 and 4.3 are the bar charts for the mean scores for pretest and posttest of the students' achievement, attitude and practical skills scores associated with treatment as presented earlier in Table 4.1.

Figure 4.1 is the bar chart showing descriptive statistics associated with treatment on achievement' mean scores.

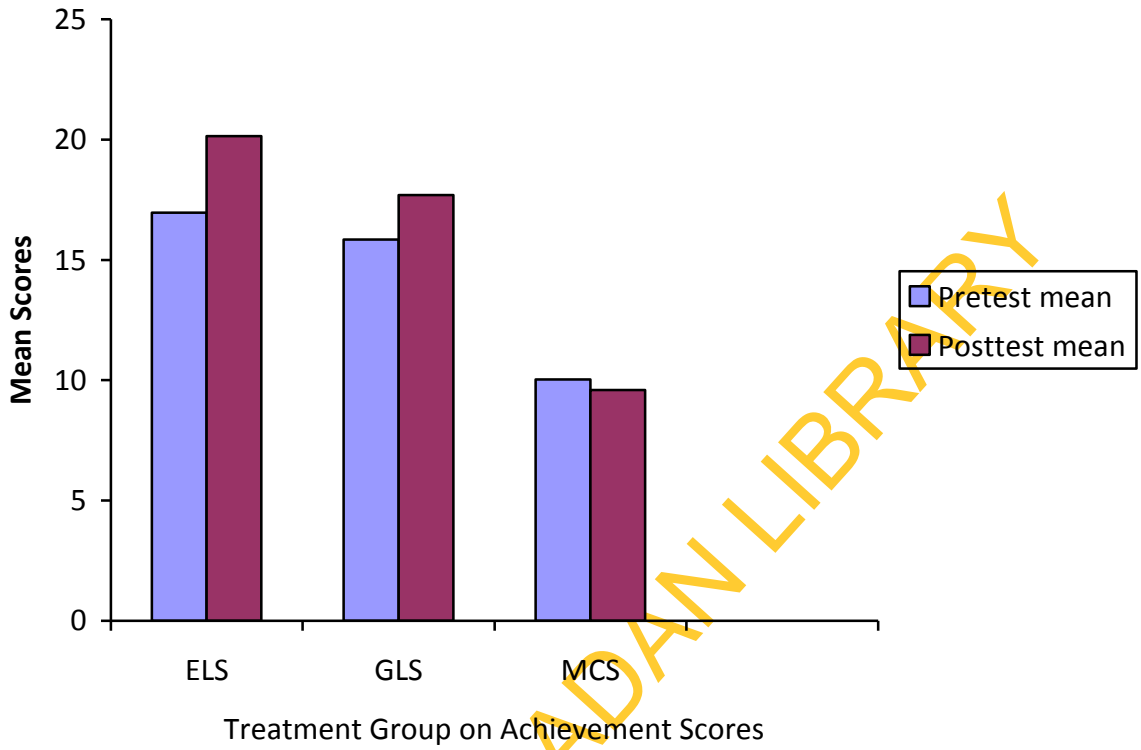

Fig 4.1: Bar chart showing the mean scores associated with treatment on students' achievement.

- Experiential Learning Strategy
- Generative Learning Strategy
- MCS - Modified Conventional strategy.

The posttest scores improved for Experiential learning strategy in achievement scores by 3.17. (Pretest mean =16.97, Posttest mean = 20.14); Generative Learning Strategy posttest scores show improvement with 1.84 (Pretest mean = 15.85, .Post-Test mean = 17.99). In the case of Modified conventional strategy, the posttest scores did not improve in achievement (Pretest mean = 10.03, Posttest mean = 9.59). The mean gain in descending order is:

Experiential learning strategy had higher mean gain than Generative Learning Strategy, while Generative Learning Strategy had higher mean gain than Modified Conventional Strategy.

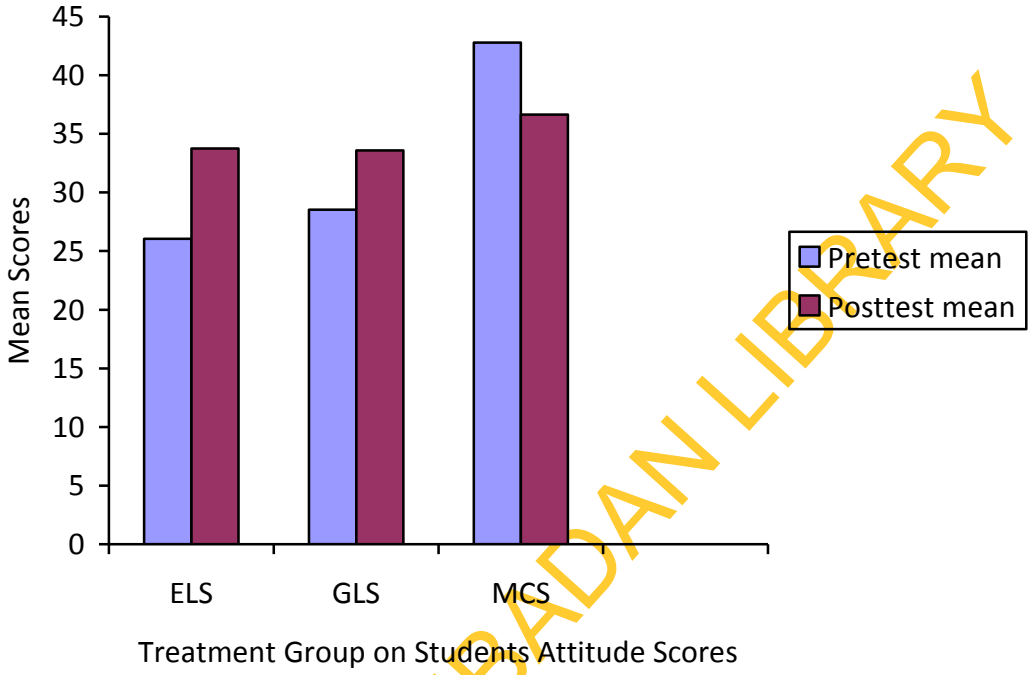

Fig 4.2: Bar chart showing the mean scores Associated with Treatment on students' attitude.

- Experiential Learning Strategy
- Generative Learning Strategy
- MCS - Modified Conventional Strategy

The posttest scores improved for Experiential learning strategy in attitude scores by 10.57. (Pretest mean =26.06, Posttest mean = 36.63). Generative Learning Strategy posttest scores showed improvement with 5.22 (Pretest mean =28.53, Posttest mean =33.75). In the case of Modified conventional strategy, the post test scores did not improve in attitude scores (Pretest mean =42.79, Posttest mean = 33.59). The mean gain in descending order is: Experiential learning strategy had higher mean gain than Generative Learning Strategy, while Generative Learning Strategy had higher mean gain than Modified Conventional Strategy.

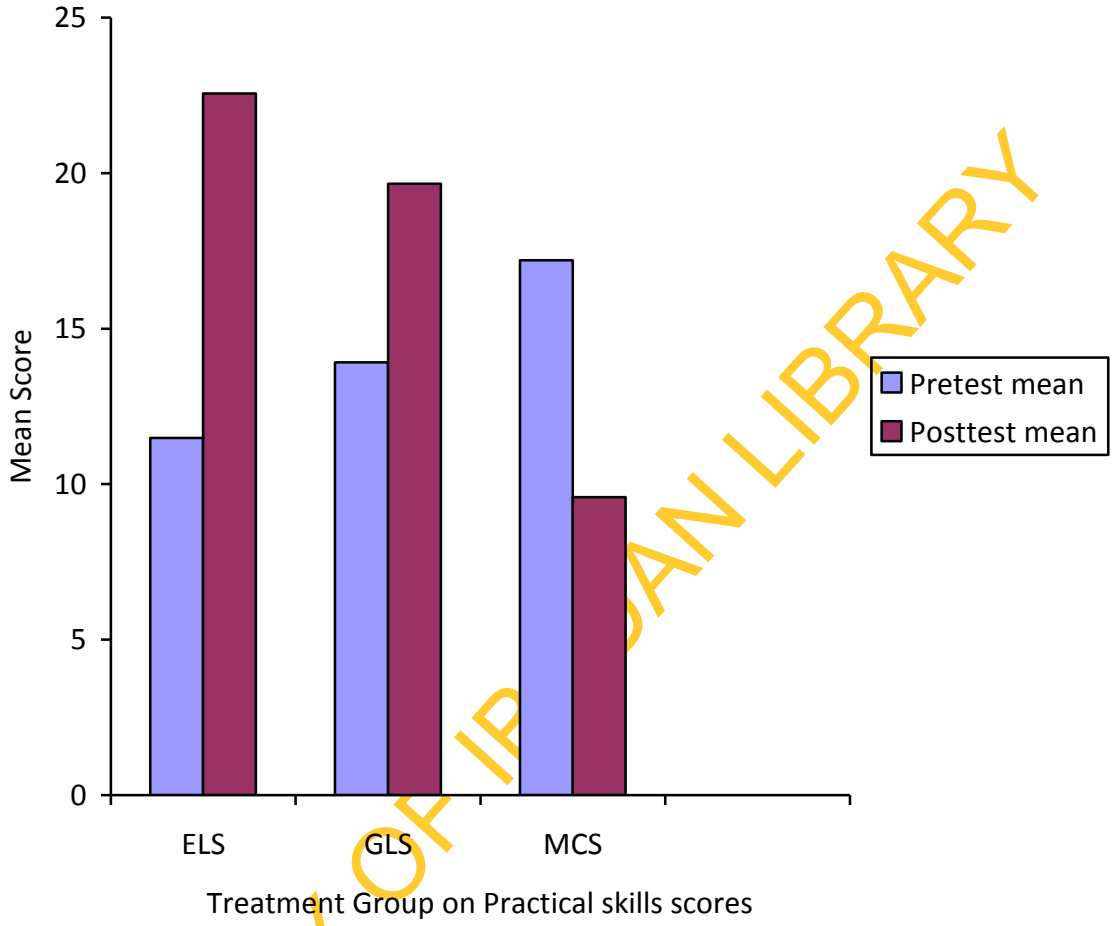

Fig 4.3: Bar chart showing the mean scores associated with treatment on students' Practical skills.

- ELS- Experiential learning's strategy
- GLS- Generative Learning Strategy
- MCS - Modified Conventional strategy

The post test scores improved for Experiential learning strategy in practical skills' scores by 11.07. (Pretest mean =11.49, Posttest mean = 22.56) and Generative Learning Strategy post test scores showed improvement with 5.74 (Pretest mean =13.92, Posttest mean =19.66). In the case of Modified conventional strategy, the post test scores did not improve in practical skills' scores. (Pretest mean =17.20, Posttest mean =9.58). The mean gain in descending order is: Experiential learning strategy had the highest mean gain followed by Generative Learning Strategy, while Modified Conventional Strategy had the least mean gain.

Table 4.2: The mean scores of Students' Achievement, Attitude and Practical skills' scores Associated with Gender

	Achievement Scores		Attitude scores		Practical skills scores	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
No of cases	209	220	209	220	209	220
Pre-test mean	13.65	12.69	38.80	36.54	19.87	17.20
Pre-test S.D	0.15	0.01	0.10	0.06	0.20	0.06
Posttest mean	15.88	15.72	34.91	34.40	17.34	17.15
Posttest S.D	4.95	6.29	2.38	3.03	2.38	3.03
Mean Gain	2.23	3.03	-3.89	-2.14	-2. 53	-.05

The mean gain scores indicate that female students had higher mean gain than male students in all the three variables measured.

Figures 4.4, 4.5 and 4.6 are the bar charts showing the mean scores of students' achievement, attitude and practical skills scores associated with gender as presented in Table 4.2.

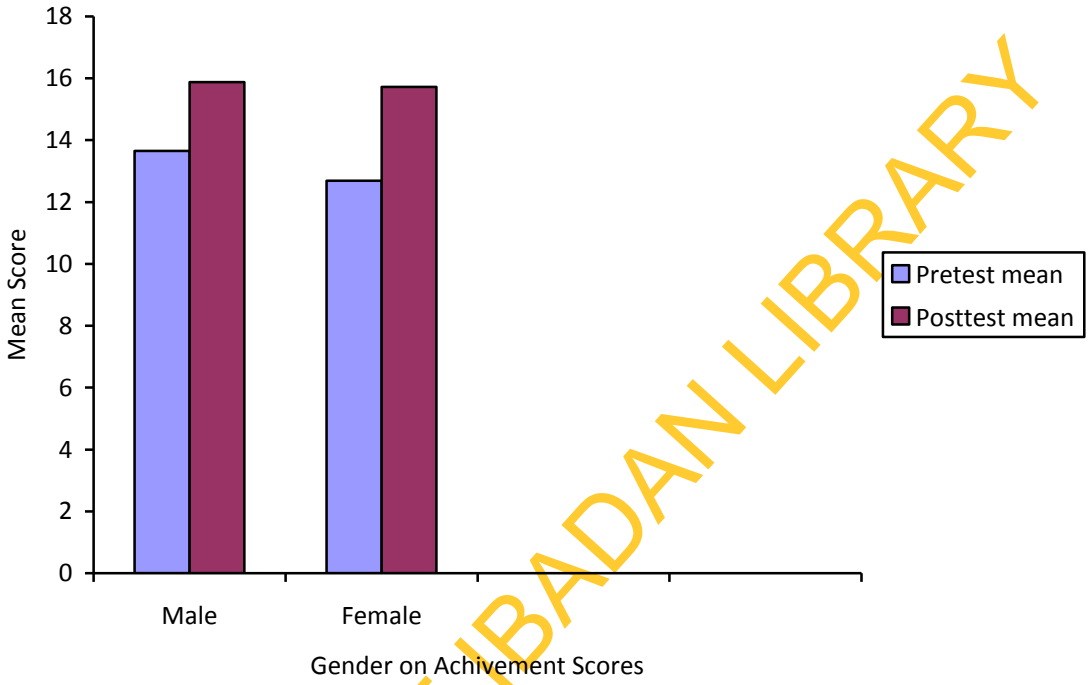

Fig 4.4: Bar chart showing the mean scores associated with students' achievement according to gender

There were improvements in males and females posttest achievement scores with 2.23 (Pretest mean = 13.65, Posttest mean = 15.88) and 3.03.(Pretest mean =12.69, Posttest mean =15.72) respectively.

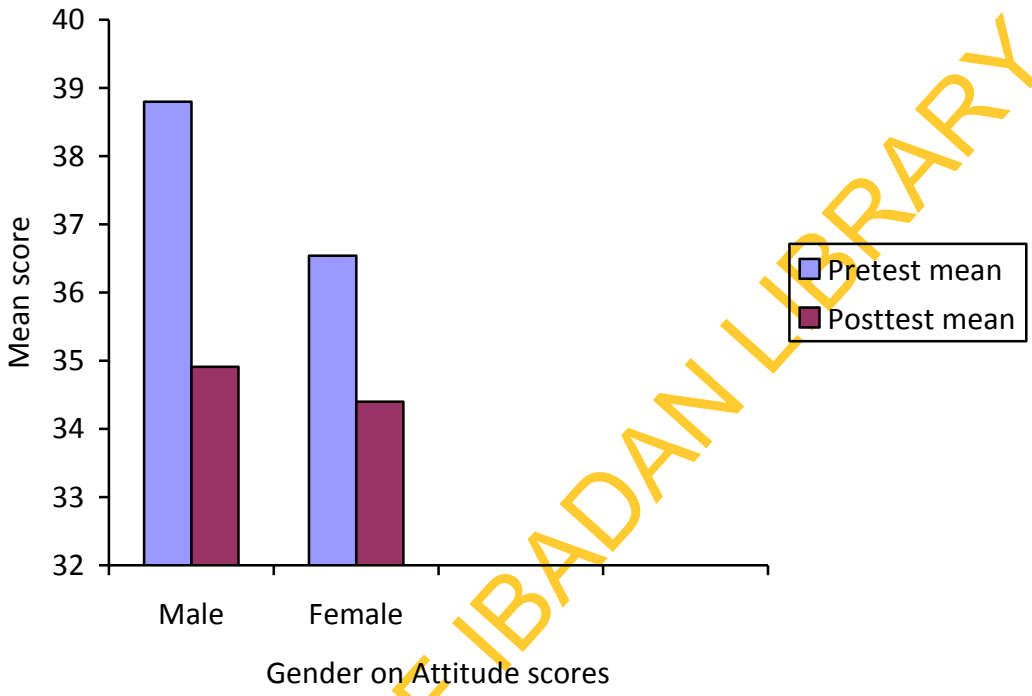

Fig 4.5: Bar chart showing the mean scores of students' attitude according to gender

There were no improvements for males and females posttest attitudinal scores with -3.89. (Pretest mean =38.80, Posttest mean = 34.91) and -2.14. (Pretest mean =36.54, Posttest mean = 34.40) respectively. The attitude of male and female students to selected concept did not even improve as shown by the posttest scores after the treatment.

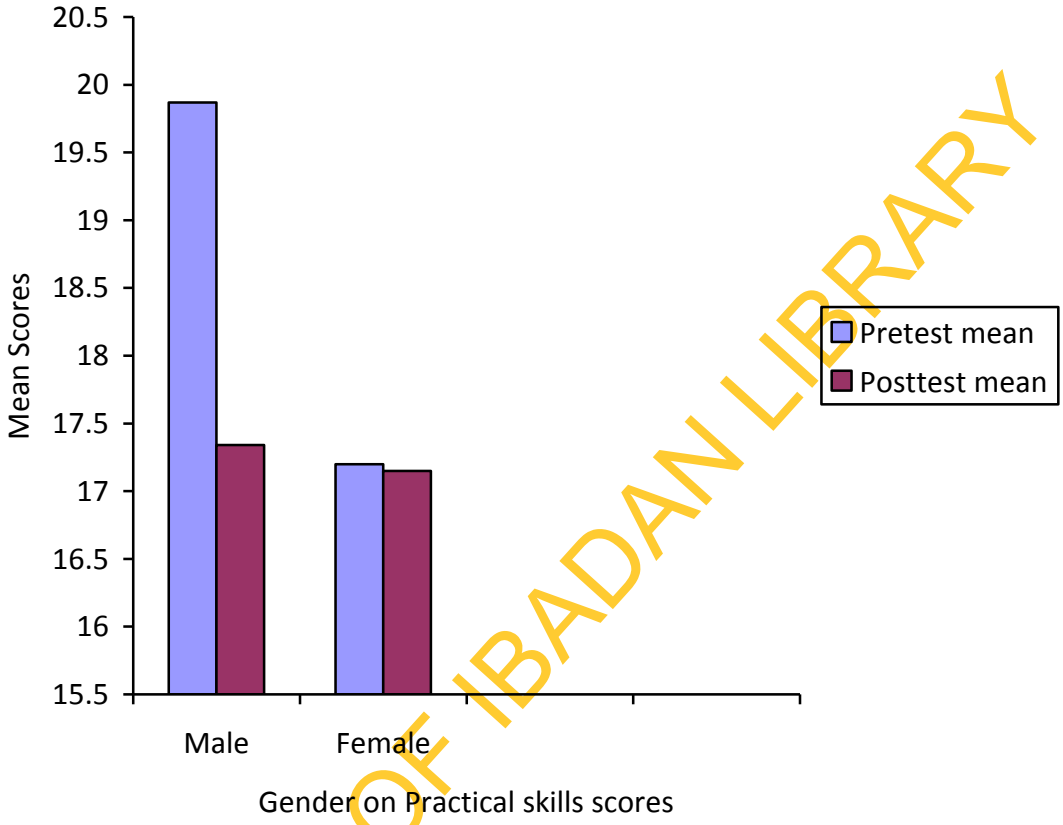

Fig 4.6: Bar chart showing the mean scores of students' practical skills associated with gender.

There were no improvements in males and females practice scores with -2. 53. (Pretest mean =17.20, Posttest mean =17.15) and - 0.5. (Pretest mean =19.87, Posttest mean =17.34) respectively.

Table 4.3: Mean scores of students' achievement, attitude and practical skills associated with mental ability.

Table 4.3 shows the mean scores of the students' achievement, attitude and Practical' skills associated with mental ability

	Achievement Scores			**Attitude scores**			**Practical skills scores**		
	High	Medium	Low	High	Medium	Low	High	Medium	Low
No of cases	63	289	87	63	289	87	63	289	87
Pre-test mean	14.41	14.41	14.12	23.63	29.49	43.25	7.44	11.41	24.76
Pre-test S.D	2.92	3.99	3.28	3.11	3.68	3.36	2.05	3.34	3.18
Posttest mean	17.58	16.25	13.58	34.20	34.71	35.05	17.51	17.15	17.14
Posttest S.D	4.17	4.54	5.00	2.01	2.16	2.39	1.99	2.15	2. 42
Mean Gain	3.17	1.84	-.44	10.57	5.22	-8.20	10.07	5.74	-7.62

There were improvements in the Mean achievement scores of both high (3.17) and medium (1.84) students but a decrease for the low mental-ability students (-0.44). The same trend applied to attitudinal scores because they showed greater improvement in mean attitudinal scores for both high (10.57) and medium (5.22) students and there was no improvement in the mean attitudinal scores of low mental-ability students (-8.20). The same situation applied to mean practical skill scores of both high (10.07) and medium (5.74) students because they showed greater improvement but low mental-ability group showed no improvement (-7.62).

Figures 4.7, 4.8 and 4.9 are the bar charts showing the magnitude of mean scores of the students' achievement, attitude and practical skills' scores associated with mental ability as presented in Table 4.3.

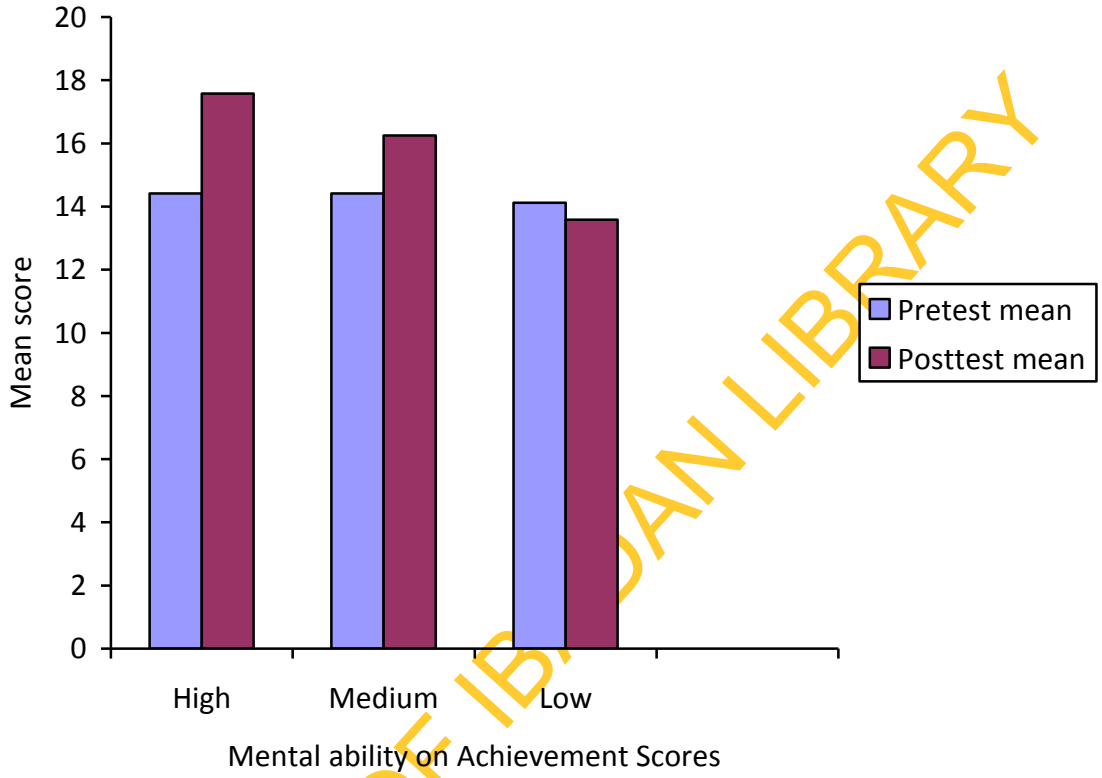

Fig 4.7: Bar Chart showing mean scores of students' achievement associated with mental ability.

There were improvements in the mean achievement scores of high mental-ability students by 2.66. (Pretest mean =14.41, Posttest mean =17.58) and medium-mental ability students by 2.71 (Pretest mean =14.41, Posttest mean =16.25), while the scores of low mental-ability students declined by -0.44 (Pretest mean =14.12, Posttest mean =13.58.

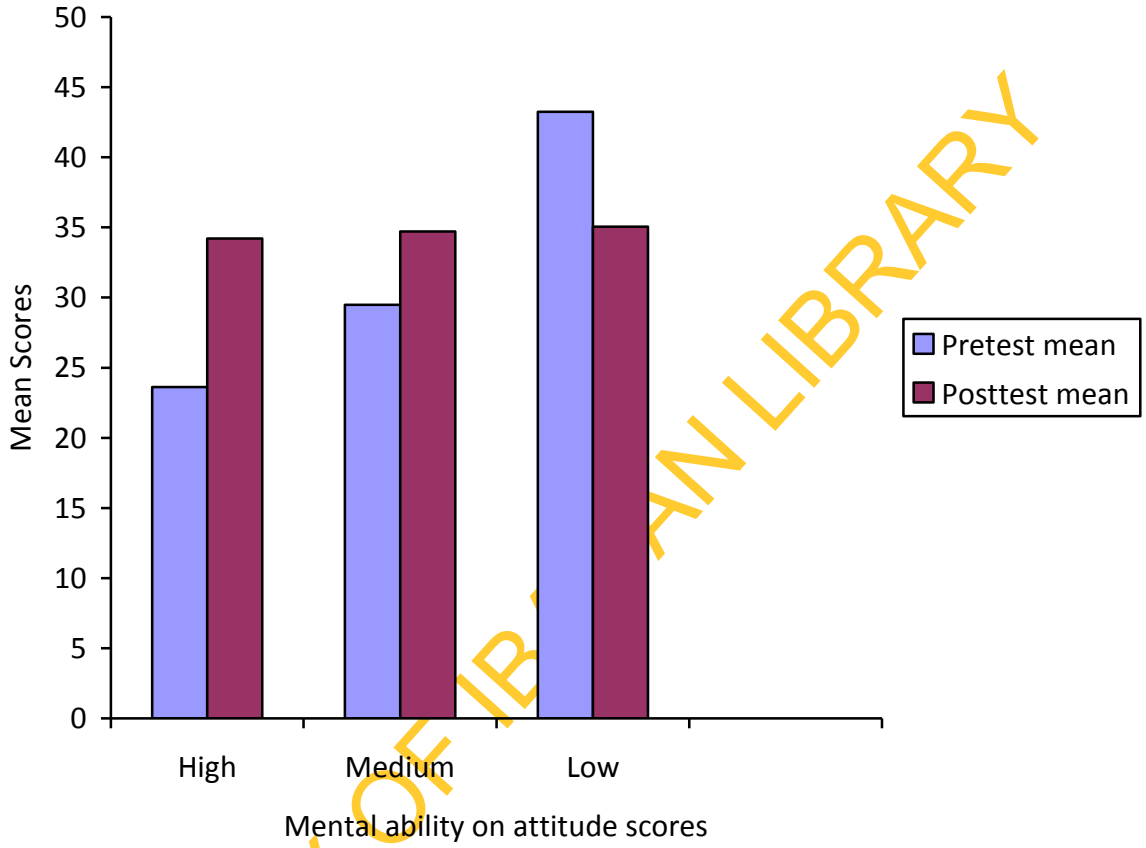

Fig 4.8: Bar chart showing the mean scores of students' attitude associated with mental ability

There were improvements in the mean attitudinal scores of high mental ability by 10.57. (Pretest mean =23.63, Posttest mean =34.20) and those students with medium mental ability by 5.22 (Pretest mean =29.49, Posttest mean =34.71), while scores of students with the low mental ability reduced by -8.20 (Pretest mean =43.25, Posttest mean =35.05)

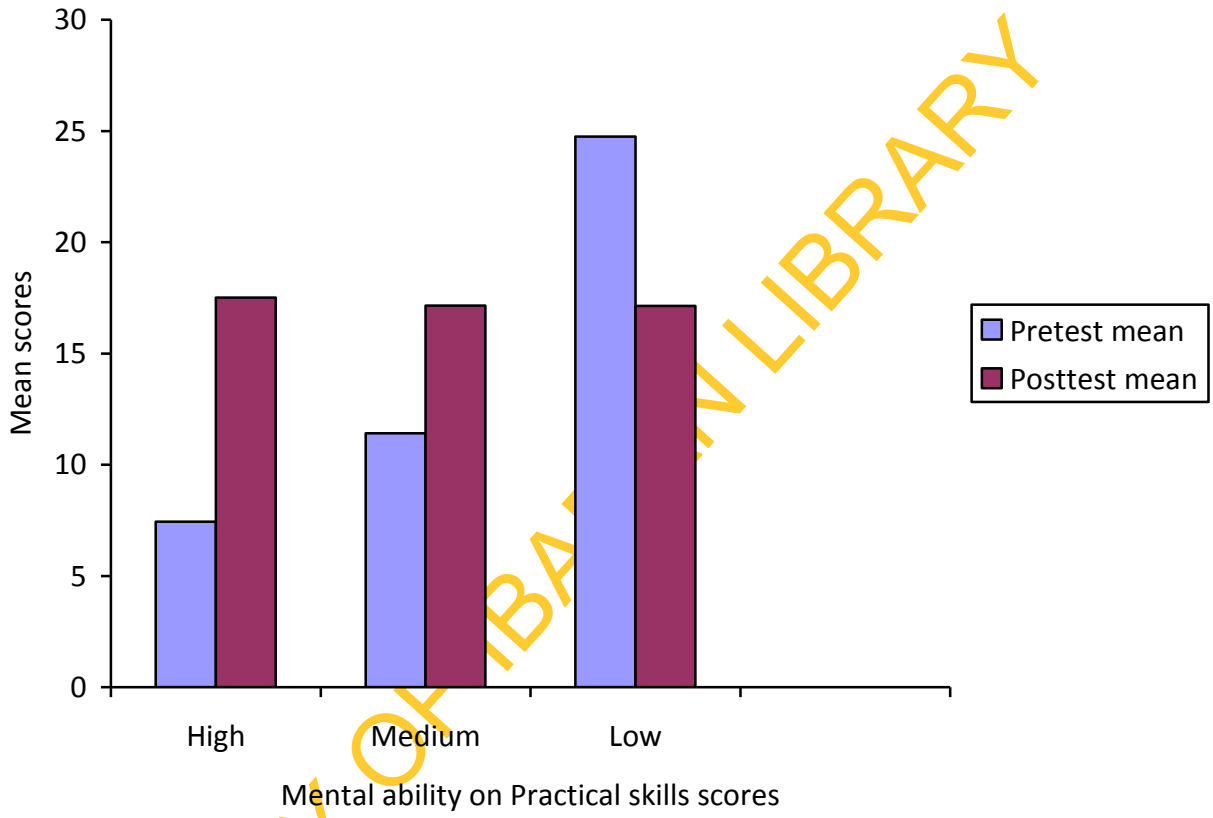

Fig 4.9: Bar chart showing the mean scores of students' practical skills associated with mental ability

The mean practical skills scores of high mental ability students showed greater improvement by 10.07 (Pretest mean =7.44, Posttest mean =17.51) and medium mental ability by 5.74 (Pretest mean = 11.41, Posttest mean = 17.15) than that of low mental ability students by -7.62. (Pretest mean =24.76, Posttest mean = 17.14).

4.2 Testing of Hypotheses

4.2.1a$H_0$1a: There is no significant main effect of treatment on students' Academic Achievement in Biology.

Table 4.4: Effects of treatment, Gender and Mental Ability on students' achievement in Biology

Source	Sum of Squares	DF	Mean Square	F	Sig.	Eta Squared
Corrected Model	9825.038	18	547.335	106.737	.000*	0.824
Pre-Achievement	18.063	1	18.063	3.522	0.061	0.009
Main Effect:						
Treatment Group	5355.580	2	2677.790	522.200	.000*	0.718
Gender	1.423	1	1.423	.278	0.599	0.001
Mental Ability	578.696	2	289.348	56.426	.000*	0.216
2-Way Interactions:						
Treatment X Gender	7.755	2	3.878	.756	0.470	0.114
Treatment X Mental Ability	37.675	4	9.419	1.837	0.121	0.018
Gender X Mental Ability	22.163	2	11.082	2.161	0.117	0.010
3-way Interactions:						
Treatment x Gender x Mental Ability	11.023	4	2.756	.537	0.708	0.005
Error	2102.438	410	5.128			
Total	11954.476	428				

* Significant at p < .05

Table 4.4, showed that there was significant main effect of treatment on students' posttest academic achievement in Biology.

($F_{(2,410)} = \mathbf{522.200}$, $p < .05$, $\eta^2 = 0.718$). The effect size of 71.8% was moderate. Therefore, hypothesis 1a was rejected. The estimated marginal means of the treatment groups were computed to determine the magnitude of achievements' mean scores across the treatment groups. The information is as shown in table 4.5 below.

Table 4.5: Estimated Marginal Means of Posttest of Achievement scores by Treatment.

Treatment groups	Mean	Std. Error	95% Confidence Interval	
			Lower bound	Upper bound
Experiential Learning Strategy (ELS)	20.141	0.249	19.651	20.631
Generative Learning Strategy (GLS)	17.687	0.275	17.146	18.228
Modified Conventional Strategy (MCS)	9.592	0.235	9.131	10.053

Table 4.5 reveals that students exposed to Experiential Learning Strategy had the highest adjusted post mean score ($\bar{x}$=20.141); followed by those exposed to Generative Learning Strategy with mean score ($\bar{x}$= 17.687), while those exposed to modified conventional strategy had the least adjusted mean score ($\bar{x}$= 9.592).

To determine the direction of the significant difference among the different groups, Scheffe Post hoc analysis was carried out and the results are shown in Table 4.6

Table 4.6: Scheffe Post hoc Test of Treatment by Achievement

			Treatment		
	N	$\bar{x}$	Experiential Learning Strategy	Generative Learning Strategy	Modified Conventional Strategy
Experiential Learning Strategy	146	20.141		*	*
Generative Learning Strategy	141	17.687			*
Modified Conventional Strategy	142	9.592	*	*	

* Pairs significance (2)-ntly different at p < .05.

Table 4.6 shows that the mean score of the group exposed to Experiential Learning Strategy was significantly different ($\bar{x}$ = 20.141) from the scores of students exposed to Generative Learning Strategy ($\bar{x}$= 17.687) and Modified Conventional Strategy ($\bar{x}$ = 9,592). Also, the mean score under Generative Learning Strategy was significantly different from Modified Conventional Strategy (MCS). Therefore, the significant effect of treatment on achievement was due to significant differences obtained between Experiential learning strategy and Generative learning strategy, as well as those obtained in Generative learning strategy and Modified conventional strategy.

4.2.1b H01b: There is no significant main effect of treatment on students' Attitude to Biology.

Table 4.7: Effects of treatment, Gender and Mental Ability on students' attitude towards Biology

Source	Sum of Squares	DF	Mean Square	F	Sig.	Eta Squared
Corrected Model	775.315	18	43.073	2.132	0.005	0.086
Pre-Achievement	143.464	1	143.464	7.102	0.008	0.017
Main Effect:						
Treatment Group	112.973	2	56.486	2.796	0.062	0.073
Gender	15.688	1	15.688	0.777	0.379	0.002
Mental Ability	21.303	2	10.652	527	0.591	0.003
2-Way Interactions:						
Treatment X Gender	50.274	2	25.137	1.244	0.289	0.006
Treatment X Mental Ability	10.007	4	2.502	1.769	0.135	0.025
Gender X Mental Ability	77.371	2	38.686	1.915	0.149	0.009
3-way Interactions:						
Treatment x Gender x Mental Ability	45.610	4	11.403	0.978	0.419	0.005
Error	8281.683	410	20.199			
Total	9056.998	428				

Table 4.7 shows that there was no significant main effect of treatment on students posttest attitude to Biology ($F_{(2,410)} = 2.796$; $p < .05$, $\eta^2 = 0.13$). The effect size of 73% was moderate. Therefore, hypothesis 1b was not rejected.

To determine the magnitude of attitude mean scores across the treatment groups, the estimated marginal mean of the treatment groups were determined. The results are as represented in Table 4.8 below.

Table 4.8: Estimated marginal means of posttest of attitude by treatment.

Treatment groups	Mean	Std. Error	95% Confidence Interval	
			Lower bound	Upper bound
Experiential Learning Strategy	33.746	0.672	32.425	35.067
Generative Learning Strategy	33.590	0.621	32.370	34.810
Modified Conventional strategy	36.632	0.903	34.857	38.407

Table 4.8 reveals that students exposed to experiential learning strategy (ELS) had the adjusted post mean score (F = 33.746), followed by those exposed to Generative Learning Strategy with mean score ($\bar{x}$ = 33.590) and lastly those exposed to modified conventional strategy with the highest mean score ($\bar{x}$ = 36.632).

4.2.1cH01c There is no significant main effect of treatments on students' practical skills in Biology

Table 4.9: Effects of treatment, Gender and Mental Ability on students' Practical skills in Biology

Source	Sum of Squares	DF	Mean Square	F	Sig.	Eta Squared
Corrected Model	12603.023	18	700.168	232.836	0.000	0.911
Pre-Achievement	35.365	1	35.365	11.760	0.001	0.028
Main Effect:						
Treatment Group	7814.498	2	3907.249	1299.326	0.000*	0.864
Gender	.142	1	.142	.047	0.828	0.000
Mental Ability	5.350	2	2.675	.890	0.412	0.004
2-Way Interactions:						
Treatment X Gender	1.573	2	.786	.262	0.770	0.001
Treatment X Mental Ability	17.183	4	4.296	1.429	0.224	0.014
Gender X Mental Ability	1.159	2	.579	.193	0.825	0.001
3-way Interactions:						
Treatment x Gender x Mental Ability	22.946	4	5.736	1.908	0.108	0.018
Error	1232.925	410	3.007			
Total	13835.949	428				

Table 4.9 reveals that there was a significant main effect of treatment on students' posttest practical skills in Biology ($F_{(2,4100} = 1299.326$, $p < .05$, $\eta 2 = .864$). The effect size of 86.4% was moderate. Therefore, hypothesis 1c was rejected.

To determine the magnitude of practical skills mean scores across the treatment groups, the estimated marginal means of the treatment groups were determined. The information is presented in table 4.10.

Table 4.10: Estimated marginal means of posttest of practical skills by Treatment.

Treatment groups	Mean	Std. Error	95% Confidence Interval	
			Lower bound	Upper bound
Experiential learning's strategy	22.558	.192	22.181	22.936
Generative Learning Strategy	19.664	.211	19.250	20.079
Modified Conventional strategy	9.580	.182	9.222	9.938

Table 4.10 reveals that students exposed to Experiential Learning Strategy had the highest adjusted mean score ($\bar{x}$ = 22.558); followed by those exposed to Generative Learning Strategy, with mean score ($\bar{x}$ = 19.664), while those exposed to the modified conventional strategy had the least mean score ($\bar{x}$= 9.580). To determine the direction of the significant difference among the different groups, Scheffe post hoc analysis was computed and the result is shown in Table 4.11

Table 4.11: Scheffe post hoc analysis of Treatment by Practical skills

			Treatment		
	N	$\bar{x}$	Experiential Learning Strategy	Generative Learning Strategy	Modified Conventional Strategy
Experiential Learning Strategy	146	22.558		*	*
Generative Learning Strategy	141	19.664			*
Modified Conventional Strategy	142	9.580	*	*	

Table 4.11 reveals that the scores of the students exposed to experimental learning strategy was significantly different ($\bar{x}$ = 22.558) the scores of students exposed to generative learning strategy ($\bar{x}$ = 19.664) and modified conventional strategy ($\bar{x}$ = 9.580). Therefore, the significant effect of treatment on practical skills was due to significant difference obtained between experimental learning strategy and generative learning strategy as well as those obtained in generative learning strategy and modified conventional strategy.

4.2.2aHo2a: There is no significant main effect of gender on students' academic achievement in Biology.

Table 4.4 shows that there was no significant main effect of gender on students' academic achievement in Biology ($F_{(1,410)}$ = 0.278, $\eta 2$ = 0.001). The effect size of 0.1% was negligible. Therefore, hypothesis 2a was not rejected.

To determine the magnitude of academic achievement mean scores across gender, the estimated mean score of the treatment groups was computed as shown in Table 4.12.

Table 4.12 Estimated Marginal means of Posttest of Achievement scores by Gender

GENDER	Mean	Std. Error	95% Confidence Interval	
			Lower bound	Upper bound
MALE	15.884	.212	15.466	16.302
FEMALE	15.729	.202	15.332	16.127

Table 4.12 reveals that males had a slightly higher mean value ($\bar{x}$ = 15.884) than females ($\bar{x}$ = 15.729). However, the difference in their means was not significant.

4.2.2b HO2b. There is no significant main effect of gender on students' attitude to Biology.

Table 4.7 shows that there was no significant main effect of gender on students' attitude to Biology ($F_{(1,410)} = 0.777$, $p < .05$; $\eta 2 = 0.002$). The effect size of 2% was negligible. Therefore hypothesis 2b was not rejected. To determine the magnitude of attitude mean scores across the gender groups, the estimated marginal mean that was computed is as presented in Table 4.13.

Table 4.13: Estimated marginal means of students' posttest attitude by Gender

GENDER	Mean	Std. Error	95% Confidence Interval	
			Lower bound	Upper bound
MALE	34.912	.421	34.084	35.739
FEMALE	34.400	.400	33.613	35.187

The estimated marginal mean shows that male had higher mean score ($\bar{x}$ = 34.912), than female ($\bar{x}$ = 34.400), but the difference between their means was not significant.

4.2.2cHO2c. There is no significant main effect of gender on students' practical skills in Biology.

From table 4.9, it is clear that there was no significant main effect of gender on students' posttest practical skills in Biology ($F_{(1,410)}$ = 0.047, p < 0.05, $\eta 2$ = .828). The effect size of 82.8% was moderate. Therefore, hypothesis 2c was not rejected. To determine the magnitude of practical skills mean scores across the gender groups, the estimated marginal means shown in Table 4.14 were computed.

Table 4.14: Estimated marginal mean of students' posttest practical skills in Biology by Gender

GENDER	Mean	Std. Error	95% Confidence Interval	
			Lower bound	Upper bound
MALE	17.338	0.160	17.024	17.653
FEMALE	17.153	0.159	16.841	17.468

Table 4.14 reveals that male had higher mean score ($\bar{x}$ = 17.338) than females ($\bar{x}$ = 17.153), but the difference between their means was not significant.

4.2.3aH03a.There is no significant main effect of mental ability on students' academic achievement in Biology.

Table 4.4 reveals that there was a significant effect of mental ability on the students' academic achievement in Biology ($F_{(2,410)} = .000, p < .05, \eta^2 = .216$). The effect size of 21.6% was moderate. Therefore, hypothesis 3a was rejected. To determine the magnitude of posttest achievement mean score of students by mental ability, the estimated marginal means presented in Table 4.15 were computed.

Table 4.15: Estimated marginal means of posttest achievement scores of students by mental ability

Mental ability	Mean	Std. Error	95% Confidence Interval	
			Lower bound	Upper bound
High	17.584	0.327	16.942	18.227
Medium	16.253	0.136	15.986	16.519
Low	13.583	0.260	13.072	14.093

Table 4.15 shows that students with high mental ability had the highest adjusted mean score ($\bar{x}$ = 17.584), followed by students with medium mental ability ($\bar{x}$= 16.253); while students with low mental ability had the least adjusted mean score ($\bar{x}$= 13.583). To determine the direction of the significance among the different levels of mental ability, Scheffe post-hoc analysis was conducted and the result is as presented in Table 4.16.

Table 4.16: Scheffe Post-hoc analysis of students' mental ability according to Achievement

			Mental Ability		
Mental Ability	N	$\bar{x}$	High	Medium	Low
High	63	17.553			*
Medium	289	16.296			*
Low	87	13.598	*	*	

Table 4.16 reveals that the score of students in high mental ability group was significantly different ($\bar{x}$ = 17.553) from the score of those in low mental ability group. The score of students in medium mental ability group ($\bar{x}$= 16.289) was also significantly different from the one obtained by those in low mental ability group ($\bar{x}$ = 13.598). Both high and medium mental ability groups are different from low ability group but not different from each other. The significant effect therefore was due to significant difference obtained between high mental ability with medium and low mental ability.

4.2.3bH03b: There is no significant main effect of mental ability on students' attitude to Biology.

From Table 4.7, it is clearly revealed that there was no significant main effect of mental ability on students attitude to Biology ($F_{(2,410)} = .527$, $p < .05$; $\eta^2 = .003$). The effect size of 3% was negligible. Therefore hypothesis 3b was not rejected.

To determine the magnitude of attitude mean scores across the high, medium and low levels of mental ability, the adjusted mean score for students' attitude to Biology that was obtained is presented in Table 4.17.

Table 4.17: Estimated marginal means of posttest attitude scores of students by mental ability

Mental ability	Mean	Std. Error	95% Confidence Interval	
			Lower bound	Upper bound
High	34.201	0.649	32.925	35.478
Medium	34.714	0.269	34.184	35.243
Low	35.052	0.515	34.039	36.065

Table 4.17 reveals that students from high mental ability group obtained the adjusted mean score of 34.201, followed by those of medium mental ability group with a mean score of 34.714 and lastly those of low mental ability group that obtained the highest mean score of 35.052.

4.2.3cH03c: There is no significant main effect of mental ability on students' practical skills in Biology.

Table 4.9 indicates that there was no significant main effect of mental ability on students' posttest practical skills in Biology ($F_{(2,410)} = 0.890$, $p < .05$, $\eta 2 = .004$).

The effect size of 4% was negligible. Therefore, hypothesis 3c was not rejected. To determine the magnitude mean score, the adjusted mean score for students' practical skills by mental ability is thereby presented in Table 4.18.

Table 4.18 Estimated Marginal means of Posttest Practical skills of students by Mental Ability

Mental ability	Mean	Std. Error	95% Confidence Interval	
			Lower bound	Upper bound
High	17.507	0.250	17.015	17.999
Medium	17.154	0.104	16.950	17.358
Low	17.142	0.199	16.751	17.533

Table 4.18 indicates that student in high mental ability group had the highest adjusted mean score ($\bar{x}$ = 17.507), followed by students in medium mental ability group ($\bar{x}$ = 17.154), while the least mean score was obtained by students in low mental ability group ($\bar{x}$ = 17.142).

4.2.4aH04a: There is no significant interaction effect of treatment and gender on students' academic achievement in Biology.

Table 4.4 indicates that there was no significant interaction effect of treatment and gender on students' academic achievement in Biology ($F_{(2,410)}$ = -0.756, P < .05, $\eta 2$ = 0.004). Therefore, hypothesis 4a was not rejected.

4.2.4bH04b: There is no significant interaction effect of treatments and gender on students' attitude to Biology.

Table 4.7 indicates that there was no significant interaction effects of treatment and gender on students' attitude to Biology ($F_{(2,410)}$ = 0.289, p < .05, $\eta 2$ = .006**)**. Thus, hypothesis 4b was not rejected.

4.2.4cH04c: There will be no significant interaction effects of treatment and gender on students' practical skills in Biology.

Table 4.9 shows that there was no significant interaction effect of treatment and gender on students' practical skills in Biology ($F_{(2,410)}$ = .770, p < .05, $\eta 2$ = .001). Thus, hypothesis 4c was not rejected.

4.2.5aH05a: There is no significant interaction effect of treatments and mental ability on students' academic achievement in Biology

Table 4.4 has revealed that there was no significant interaction effect of treatment and mental ability on students' academic achievement in Biology ($F_{(4,410)}$ = 1.837, p < .05, n2 = .018). Therefore, hypothesis 5a was not rejected.

4.2.5bH05b: There is no significant interaction effect of treatment and mental ability on students' attitude to Biology.

Table 4.7 indicates that there was no significant interaction effect of treatment and mental ability on students' attitude to Biology (F $(_{4,410)}$ = 1.769, p < .05, η^2 = 0.025. Therefore, hypothesis 5b was not rejected.

4.2.5cH05c: There is no significant interaction effect of treatment and mental ability on practical skills of students in Biology.

From table 4.9, it has been revealed that there was no significant interaction effect of treatment and mental ability on practical skills of students in Biology ($F_{(4,410)}$ = 1.459, p < .05, $\eta 2$ = 0.14). Therefore, hypothesis 5c was not rejected.

4.2.6aH06a: There is no significant interaction effect of gender and mental ability on students' academic achievement in Biology.

Table 4.4 indicates that there was no significant interaction effect of gender and mental ability on students' academic achievement in Biology ($F_{(2,410)}$ = 2.161, p < .05, η^2 = .010). Therefore, hypothesis 6a was not rejected.

4.2.6bH06b: There is no significant interaction effect of gender and mental ability on students' attitude to Biology.

From table 4.7, it has been revealed that there was no significant interaction effect of gender and mental ability on students' attitude to Biology ($F_{(2,410)}$ = 1.915, p < .05, $\eta 2$ = 0.09). Thus, hypothesis 6b was not rejected.

4.2.6c H06c: There is no significant interaction effect of gender and mental ability on students' practical skills in Biology.

Table 4.9 reveals that there was no significant interaction of gender and mental ability on students' practical skills in Biology. ($F_{(2,410)}$ = .193, p < .05, $\eta 2$ = .001). Thus, hypothesis 6c was not rejected.

4.2.7a H07a: There is no significant interaction effect of treatment, gender and mental ability on students' academic achievement in Biology.

From Table 4.4, it is clear that there was no significant interaction effect of treatment, gender and mental ability on students academic achievement in Biology ($F_{(4,410)} = .537$, $p < .05$, $\eta^2 = .005$). Thus, hypothesis 7a was not rejected.

4.2.7bH07b: There is no significant interaction effect of treatment, gender and mental ability on students' attitude to Biology.

From table 4.7, it is clear that there was no significant 3-way interaction effect of treatment, gender and mental ability on students' attitude to Biology ($F_{(4,410)} = 0.978$, $p < .05$, $\eta^2 = 0.005$). Thus, hypothesis 7b was not rejected.

4.2.7cH07c: There is no significant interaction effect of treatment, gender and mental ability on students' practical skills in Biology.

Table 4.9 indicates that there was no significant interaction effect of treatment, gender and mental ability on students' practical skills in Biology ($F_{(4,410)} = 1.908$, $p < .05$, $\eta^2 = 0.018$). Thus, hypothesis 7c was not rejected.

4.3 DISCUSSION OF FINDINGS

4.3.1a Effects of Treatment on Students' Academic Achievement in Biology

The results obtained on **e**ffects of treatment on Students' academic achievement in Biology in this study revealed that there was significant main effect of treatment on students' achievement in Biology. The result proved that Experiential learning strategy was more effective at improving the students' performance in Biology, followed by Generative learning strategy and the Modified conventional strategy. The effectiveness of experiential learning strategy and that of generative learning strategy over the modified conventional strategy may be due to the fact that experiential and generative learning strategies are learner-centred. This may have helped the students in the groups to create knowledge through the transformation of experience. The students were helped by the strategies to learn through reflection on doing i.e. active participation, which focuses on the learning process for the individual.

This finding is in agreement with those of Jolaoso (2012); Jegede (2012); Daramola (2007) and Bart et al (2005). Daramola found improvement in Biology, Bart *et al* in Physics, Jolaoso also in Physics with the use of Experiential learning strategy.

This study also revealed that students exposed to Generative learning strategy performed better than those exposed to Modified conventional strategy by interpretation, thus indicating that Generative learning strategy was more effective. This may be due to the fact that the strategy helped students' ability to generate knowledge, communicate and learn among themselves. This finding is in agreement with the submissions of Ogunleye *et al*, (2011); and Cyprus *et al*, (2011). Hyeon *et al*, (2005); Grabowski (2004) and Faralinaz, (2002) also reported the use of Generative learning strategy as been effective to enhance students' academic achievement in Biology. It is in the light of this that researchers say "It is of paramount importance for the educators to search for ways to improve students' achievement" (Mariya, 2010). They all found out that Generative learning strategy improved students' performance in subjects like Physics, Chemistry and English language.

The poor performance of the students exposed to the Modified conventional strategy as shown by the posttest achievement scores, may be connected with the fact that conventional strategy is teacher-centred. This strategy had been found to be inadequate where the teachers 'give out' the facts to the students and the students in turn listen and digest the knowledge, therefore, the learners are made passive recipients of knowledge, (Ogundiwin, 2013; Awolere, 2006).

John Dewey's work was mainly based on children being active recipients of knowledge. He opined that learners learn by exploring their environment and there should be an integration of theory and practice, the cyclic pattern of experience and the conscious application of that learning experience (Ogundiwin, 2013)

In line with the outcome of the study, an American educational theorist David Kolb (1984) say, knowledge is continuously gained through both personal

and environmental experiences. He then stated further that "in order to gain genuine knowledge from an experience, certain abilities are required''. The abilities are:

(a) The learner must be willing to be actively involved in the experience.

(b) The learner must be able to reflect on the experience.

(c) The learner must possess and use analytical skills to conceptualize the experience.

(d) The learner must possess decision making and problem solving skills in order to use the new ideas received through the experience.

4.3.1b Effects of Treatment on Students' Attitude to Biology

The result obtained from this study revealed that the main effect of treatment on the students' attitude to Biology was not significant. This, by implication, shows that the strategies used did not positively influence the students even after the treatment. Researchers have indicated that there is a link between students' attitudes towards Biology and their learning environments (Wilson *et al*, 2009; Adolphe *et al*, 2003; Chuang and Cheng, 2003).

An attitude is a manner of thinking, feeling or behaviour that reflects a state of mind or disposition, (Afuwape, 2003). A positive attitude is the habitual, mental positioning that characterizes who a learner is. It is an optimistic outlook that allows positive thinking resulting into good success (Fredrick 2014). Attitude towards science affects course and career choices of students and it is important to examine its different aspects and reinforce weak aspects by designing different educational programs (Osborne *et al*, 2003). Attitude takes longer period of time to change due to many other factors that may come in as extraneous variables that would not allow an attitude to be pinned down. The variables could be school location, school type, parental monthly income, living conditions, parental educational background and so on. These other extraneous variables that can affect one's attitude.

Attitudes are mental predispositions toward people, objects, subjects, events, and so on. In science, attitudes are important because of three primary factors (Martin, 2010). First, a child's attitude has a mental state of readiness to it. With a positive attitude, a child will perceive science objects, topics, activities, and people positively. A child who is unready or hesitant, for whatever reason, will be less willing to interact with people and things associated with science. This readiness factor occurs unconsciously in a child, without prior thought or overt consent.

Second, attitudes are not innate or inborn. Contemporary psychologists maintain that attitudes are learned and are organized through experiences as children develop (Craker, 2006). Furthermore, a child's attitude can be changed through experience; and teachers and parents have the greatest influence on chield's science attitudes to science (Martin *et al.*, 2010).

Third, attitudes are dynamic results of experiences that act as directive factors when a child begins new experiences. As a result, attitudes have emotional and intellectual tones, both of which lead to decision making and formation of evaluations. These decisions and evaluations can cause a child to set priorities and hold different preferences.

Attitude towards academics plays an important role in productivity and academic performance. Younger children tend to have positive attitudes towards science and display many of these attitudes as they explore and interact with classmates. However, over times, these initial positive attitudes may decline (Martin *et al*., 2010). A positive attitude is conducive to academic success while a negative attitude is counter-productive (Cohen, 2013). In an attempt to describe the influence of an attitude on learning outcomes, Hassan (2000) stated and I quote, "Two men look out through the same bars: one sees the mud and the other stars''. By implication, the attitude a learner has towards a concept determines what he or she achieves in that concept.

Everyone in the world is full of some kind of attitude that someone else may not like (Bardina, 2010). Every learner has a choice in his or her life as to how he or she habitually views things- positively or negatively. If one tries to find out the causes of the undesirable attitude of the students, one will discover that some of the things that are affecting their attitude are things they can change. The physiological factors and the situations of the learners may affect their attitude even in the classroom. The factors could be illness, stressful environment, kind of foods and water taken, weight loss, anxiety, physical activity and many more.

With the use of the two strategies in the selected schools, the research assistants did all they could to positively affect attitude of the students but yet, it was not in the best interest of the learners. In life, every ending is just a new beginning. This by implication means that despite the negative attitude of the learners after the treatment, one should think of other things to be added to have an effect on the attitude. It then became obvious that one can only be motivated to have a positive attitude; no one else actually can help any other person to have it.

4.3.1c Effects of Treatment on Students' Practical Skills in Biology

The results obtained in this study revealed that there was significant effect of treatment on students' acquisition of practical skills in Biology. The result however showed that Experiential learning strategy was more effective at improving the students' acquisition of practical skills in Biology, followed by Generative learning strategy and the Modified conventional strategy. The effectiveness of experiential learning strategy and that of generative learning strategy over the modified conventional strategy may be due to the fact that experiential and generative learning strategies are learner-centred.

The two strategies were highly effective in influencing the practical skills of the students in the experimental groups. The need for students to develop pratical skills through the process of problem solving in suitable environment has been emphasized by science educators (Okeke et al, 2004). The development of

these skills is basic to scientific inquiry and the development of intellectual skills needed to learn concepts (Ibe and Madyabum, 2001).

Manipulative skills involve proper handling of apparatus, setting up of experiment as well as the preparation of instructional materials. Assessment on manipulative skills was based on direct observation of the students when they were carrying out laboratory work. Observational skills involve students' ability to observe what takes place during practical investigation. Communication skills are essential skills which involve the students' ability to represent findings of practical work in a logical manner with correct illustrations. Cognitive skills on the other hand measure the understanding of the theoretical aspect of Biology in a practical test.

4.3.2a Effects of Gender on Students' Academic Achievement in Biology

The result obtained on effect of Gender on Students' academic achievement in Biology revealed that there was no significant main effect of gender on students' academic achievement in Biology (Table 4.4). Table 4.12 also revealed that there was no marginal gap between the mean scores of males and the females in the outcome (academic achievement in Biology). The result is in line with the research reports of Oduwaiye (2009), who found no gender difference in students' academic achievement with the use of his problem-solving problem in Biology.

Gender and science education is a vital issue; gender interacts in significant ways with other social variables and must be taken into consideration (Babayemi 2014; Atwater, 2004; Rennie, 2000). Research on the biological explanation of gaps in performance suggested that differences in brain structure, hormone production, and/or maturation rates may account for girls' greater advantage in school-related tasks. Research showed that the parts of the brain responsible for processing verbal information and permitting the exchange of information between hemispheres were more highly developed in girls (Kimura, 2005). Girls also demonstrated earlier development in the brain regions responsible for impulse control, and in general, they matured earlier than boys (Viadero, 2006).

Huitt and Cain (2005) also have found significant gender group differences in favour of boys. In this regard, most girls have been found to underestimate their own academic ability and believe boys to be superior and more intelligent than them (Olagunju and Chukwuka, 2008). Solomon (2004) in his study of gender differences and students' achievement in secondary school Biology, found that boys performed better than girls in all schools taken as a group and a single sex school as shown by their mean score (52.2 for boys and 49.8 for girls) (Ogundiwin, 2013).

One may suggest that the reason for the non-significant difference between males and females in this result might be due to the fact that both sexes were given equal opportunity to actively participate in the teaching-learning process in all the treatment groups. Therefore, treatment is suitable for both sexes.

4.3.2b Effects of Gender on Students' Attitude To Biology.

The result obtained revealed that there was no significant main effect of gender on students' academic achievement in Biology (Table 4.7). Table 4.13 also revealed that there was no marginal gap between the mean scores of males and females in the outcome (Attitude to Biology).

This finding differs from other gender-related research findings. Ehikhamenor (2012), found that male students demonstrated higher ability skills in Biology than their female counterparts. The result from Osborne *et al.* (2003) indicated that girls' achievement in Biology are significantly better than boys', which is normal in terms of better achievement among Iranian girls. Also, the result differs from the report of Olagunju and Chukwuka (2008) that reported that Nigerian boys perform better than girls in Biology. Most studies showed that on the average, girls do better in schools than boys to the extent that girls get higher grades compared to their male counterpart.

The reason for the reports of the other researchers who found gender difference might be that the teaching strategies used in their studies were gender biased thereby favouring one sex over the other group. One may suggest that the

reason for the non-significant difference between males and females in this study may be due to the fact that both sexes were given equal opportunity to actively participate in the teaching-learning process with the use of all the strategies.

4.3.2c Effects of Gender on Students' Practical Skills in Biology

The result obtained with respect to gender effect on practical skills revealed that there was no significant main effect of gender on students' practical skills in Biology (Table 4.9). Table 4.14 also revealed that there was no marginal gap between the mean scores of males and females in the outcome (Practical Skills in Biology).

Gender influence on skills acquisition has generated much concern among researchers. There has been mixed results for gender performance on students' acquisition of practical skills in Biology, with boys demonstrating higher ability skills in some tasks (Okeke, 2007) and girls performing better than boys in practical skills (Bilesanmi-Awoderu, 2002). However, Oduwaiye (2009) and Raimi (2002) found no gender related difference. The finding of this study is in support of Huitt (2009) that found no gender difference in acquisition of practical skills, and Okoye (2010) who also reported no gender difference in his research work.

4.3.3a Effects of Mental Ability on Students' Academic Achievement in Biology

Table 4.15 showed that there was significant main effect of mental ability on students' academic achievement. This may be due to the fact that students with high mental ability learnt better, understood instructions and solved problems better than those with medium and low mental ability. Mental ability in this result had been found to influence the performance of students in Biology. The result supports the works of Olagunju and Chukwuka (2008), Raimi (2003), Salami (2002) and Okafor (2002). They indicate that students have varying ability levels which tend to affect learning outcomes. Studies have also shown that students of varying ability levels perform differently depending on the types of methods and

materials used for instruction (Kiboss, 2003). It is likely that the problem-solving instructional strategies used in this study had been applicable to students' learning irrespective of their varying capabilities.

The effect of mental ability cannot but be considered in a study like this. General mental ability is a term used to describe the level at which an individual learns, understands instructions and solves problems. General mental ability has been found to be the single best predictor of the extent of academic performance/achievement of students. Studies have found that students with higher general mental ability acquire more academic knowledge and acquire it faster than others. Higher levels of academic knowledge lead to better performance (Sethi, 2010 and Ayoola, 2009).

Mental ability has been found to influence performance of students in Biology (Olagunju and Chukwuka 2008; Raimi, 2003 and Salami, 2002). The global objective guiding the consideration of mental ability is that the test has the capacity to discriminate between high and low ability participants. Adekunle (2005) found that the relationship between certain capabilities of mental ability measured by academic performance of learners and intelligence test was significant. Furthermore, he found that the performance needed on a number of mental ability tests such as ability to apply knowledge in solving problems, ability to manipulate abstract concepts and relationships and test of language competence were linked to performance in school learning. Besides, measurement of cognitive skills is a measure of mental ability of students.

This finding is supported by Cognitive theory of learning. The theory opined that a learner with high intelligence will perform better than those of medium and low intelligence. In this study, students with high mental ability had the highest adjusted mean scores, followed by those with medium mental ability and those of low mental ability respectively.

4.3.3b Effect of Mental Ability on Students' Attitude to Biology

The result obtained in this study as shown in Table 4.7 revealed that there was no significant main effect of mental ability on students' attitude to. This may be due to the fact that attitude cannot only be determined by a factor but a number of factors. The result on effect of mental ability on students' attitude is not in line with the findings of Olangunju and Chukwuka (2008) and Caroll (2002) who found the relationship to be significant. This disagreement might be due to different moderator variables used by the researchers.

4.3.3c Effects of Mental Ability on Students' Practical skills in Biology

From the result obtained (shown in Tables 4.18), it was revealed that there was no significant main effect of mental ability on students' acquisition of practical skills in Biology. This may not be unconnected with the fact that whatever the mental ability of a child is, the strategies adopted are very effective in influencing the posttest scores of the learners with regards to students' acquisition of practical skills in Biology. The finding of this study corresponds with the report of Ehikhamenor (2012). Ehikhamenor (2012), found no significant main effect of mental ability on students' acquisition of practical skills in Biology also.

4.3.4a Two-Way Interaction Effects of Treatment and Gender on Students Academic Achievement in Biology.

The result obtained in this study, as shown in Table 4.4, revealed that the two-way interaction effects of treatment and gender on students' academic achievement was not significant. This result implies that regardless of the gender across the treatment groups i.e. either male or female, experiential learning strategy was still found to be more effective than both generative learning strategy and modified conventional strategy respectively. The findings therefore corroborate the studies of Ramez (2011), Baumgartner (2007) and Kolb and Kolb (2005), who all found that irrespective of the gender, experiential learning strategy

stands out to be effective in improving students' outcomes in terms of achievement and attitude.

4.3.4b Two-Way Interaction Effects of Treatment and Gender on Students' Attitudes to Biology.

The result obtained in this study, which was also shown in Table 4.7, revealed that the two-way interaction effects of treatment and gender on students' attitude to Biology was not significant.

This, by implication, revealed that the effect of treatment recorded on students' attitude was not based on students' gender. This implies that being male or female does not matter, but the kinds of treatment the students are exposed to, which are experiential learning strategy, generative learning strategy and modified conventional strategy. The study corresponds with the result obtained by Babayemi (2014).

4.3.4c Two-Way Interaction Effects of Treatment and Gender on Students' Practical Skill in Biology.

The two-way interaction effects of treatment and gender on students' practical skills in Biology was not significant. This, by a way of interpretation, means that the effect of treatment recorded on students' practical skills in Biology was not based on students' gender. This implies that being male or female does not matter, but the kinds of treatment the students are exposed to, which are experiential learning strategy, generative learning strategy and modified conventional strategy. The study corresponds with the result obtained by Ehikhamenor (2012). He found the two-way interaction effects of his treatment (a problem solving strategy) and gender on students' practical skills in Biology not to be significant.

4.3.5a Two-way interaction effect of Treatment and Mental Ability on Students' Academic Achievement in Biology

The results obtained from the study revealed that there was no significant interaction effect of treatment and mental ability on students' academic achievement in Biology. This result suggests that the mental ability of the students (high, medium or low) does not really matter but the strategies used (experiential, generative and modified convention), which resulted in some improvement in students' academic achievement in Biology with experiential being most effective, followed by the generative and lastly the modified convention, in that order. The results contradict the works of Raimi (2003) and Salami (2002) who all found mental ability as having significant influence on students' outcomes.

The reason for the difference might be due to the different school locations involved in the studies. It might even be as a result of different parental educational background of the students and even different family income perharps.

4.3.5b Two-way interaction effect of Treatment and Mental Ability on Students' Attitude to Biology.

The results obtained from the study (as shown in Table 4.7) revealed that there was no significant interaction effect of treatment and mental ability on students' attitude to Biology.

This result suggests that the mental ability of the students (high, medium or low) does not really matter but the strategies used. In order words, both experiential and generative learning strategies are very effective in teaching Biology; with experiential as the most effective, followed by the generative and lastly the modified convention, in that order. The result is not in line with the works of Olagunju and Chukwuka (2008) and Caroll (2002) who all found that based on mental ability, students at varying ability levels perform differently depending on the types of methods and materials used for the instruction.

4.3.5c Two-way interaction effect of Treatment and Mental Ability on Students' Practical Skills in Biology.

The results obtained from the study revealed that there was no significant interaction effect of treatment and mental ability on students' practical skills in Biology. This is seen in Table 4.9. This result suggests that the mental ability of the student (high, medium or low) does not really matter but the strategies used (experiential, generative and modified convention). The treatment given greatly enhanced the students' practical skills in Biology with experiential as the most effective, followed by the generative and lastly the modified convention. The results contradict the works of Raimi (2003) and Salami (2002) who all found mental ability has having significant influence on students' outcomes.

4.3.6a Two-way interaction effect of Gender and Mental Ability on Students' Academic Achievement in Biology.

The results obtained from the study revealed that there was no significant interaction effect of gender and mental ability on students' academic achievement in Biology. This is seen in Table 4.4.

This result suggests that whatever the mental ability of the student (high, medium or low), and whatever the gender (male or female), it does not really matter but the strategies used (experiential, generative and modified convention). The effect of treatment recorded on students' achievement as shown by their mean scores greatly enhanced their achievement in Biology with experiential as the most effective, followed by the generative and lastly the modified convention, in that order. The result is in conformity with the work of Temikzan (2003) but not in line with the result of Ahmed (2008).

4.3.6b Two-way interaction effect of Gender and Mental Ability on Students' Attitude to Biology

The results obtained from the study (as shown in Table 4.7) revealed that there was no significant interaction effect of gender and mental ability on students' attitude to Biology.

This result suggests that whatever the mental ability of the student (high, medium or low), and irrespective of their gender (male or female) what really matters is the strategies used (experiential, generative and modified convention). The treatment given was found to be effective in teaching Biology, with experiential as the most effective, followed by the generative and lastly the modified convention, in that order. The result supports the results obtained by Robert et al (2010), Lee (2008), Scott (2006), Zacharial et al (2004) and Hyeon et al (2003). Okoye (2010) also supports this result.

4.3.6c Two-way interaction effect of Gender and Mental Ability on Students' Practical Skills in Biology

The results obtained from the study (as shown in Table 4.9) revealed that there was no significant interaction effect of gender and mental ability on students' practical skills in Biology. This is seen according to Table 4.9.

This result suggests that the gender of the students (male or female) and whatever their mental ability (high, medium or low), the strategies adopted and used (experiential, generative and modified convention) count most. What really determined their improvement in the acquisition of practical skills in Biology was their exposure to the appropriate type of instructional strategies with experiential as the most effective, followed by the generative and lastly the modified convention, in that order.

This result supports the findings of Yara (2009) and Grant (2005) that worked on the effectiveness of experiential learning strategy on acquisition of practical skills in Biology and found the strategy very effective.

4.3.7a Three-way interaction effect of Treatment, Gender and Mental ability on Students' Academic Achievement in Biology

The result obtained from the study revealed that a three-way interaction effect of treatment, gender and mental ability on students' academic achievement in Biology was not significant. This result suggests that the gender of the students (male or female) and whatever the mental ability of the student (high, medium or

low), the strategies used (experiential, generative and modified convention) are very important. What really determined the improvement in students' academic achievement in Biology was their exposure to the appropriate type of instructional strategies with experiential as the most effective, followed by the generative and lastly the modified convention, in that order. The result is in support the findings of Babayemi (2014) and Oduwaiye (2009) who all revealed no gender difference in students' achievement.

4.3.7b Three-way interaction effect of Treatment, Gender and Mental ability on Students' Attitude to Biology.

The result obtained from the study revealed that a three-way interaction effect of treatment, gender and mental ability on students' attitude to biology was not significant.

This result suggests that whatever the gender of the students (male or female) and whatever the mental ability of the student (high, medium or low), what really matters is the strategies used (experiential, generative and modified convention). Students' exposure to the appropriate type of instructional strategies (experiential, generative and modified convention) really aided their mental ability.

This result corroborates that of Adeoye (2011) which showed that students with less positive attitude will lack the motivation to persist and do better. Osborne, Simon and Collins (2003) also identified many features as influencing one's attitude, amongst which gender is included. It is often said that, "In life, every ending is just a new beginning'', so efforts should be made to know what other factors can be added to have a positive attitude.

4.3.7c Three-way interaction effect of Treatment, Gender and Mental ability on Students' Practical skills in Biology

The result obtained from the study revealed that a three-way interaction effect of treatment, gender and mental ability on students' practical skills in Biology was not significant.

This result suggests that the gender of the students (male or female) and whatever the mental ability of the student might be (high, medium or low) do not really matter but the strategies used (experiential, generative and modified convention). What really determined their improvement in the acquisition of the practical skills in Biology was their exposure to the appropriate type of instructional strategies with experiential as the most effective, followed by the generative and lastly the modified convention, in that order. The result is in support of Grant (2005) who found no gender difference in acquisition of practical skills.

4.4 Summary of Findings

Findings of this study are summarized below.

1. There was significant main effect of treatment on students' academic achievement in Biology. Students exposed to the Experiential learning strategy had higher adjusted posttest achievement mean score than those exposed to the Generative learning strategy and modified conventional strategy. Also, in practical skills, students in the Experiential Learning strategy had higher adjusted posttest practical skills score than those in the Generative Learning strategy and modified conventional strategy groups, respectively. There was no significant main effect of treatment on students' posttest attitude to Biology
2. There was no significant main effect of gender on students' academic achievement, students' attitude to Biology and practical skills in Biology.
3. There was significant main effect of mental ability on students' academic achievement in Biology. Students with high mental ability had the highest adjusted mean score (17.55), followed by students with medium mental ability (16.30), while students with low mental ability had the least adjusted mean score of 13.58.

The main effect of mental ability on students' attitude to was not significant and that of practical skills in Biology also was not significant.

4. There was no significant interaction effect of treatment and gender on students' academic achievement, students' attitude to Biology and practical skills in Biology.
5. There was no significant interaction effect of treatment and mental ability on students' academic achievement in, attitude to and practical skills in Biology.
6. The interaction effect of gender and mental ability was not significant on students' academic achievement in, attitude to and practical skills in Biology.
7. There was no significant interaction effect of treatment, gender and mental ability on all the students' learning outcomes (student academic achievement in Biology, students' attitude to Biology and students' practical skills in Biology).

CHAPTER FIVE

SUMMARY EDUCATIONAL IMPLICATION, RECOMMENDATIONS AND CONCLUSION

5.1 Summary

The study investigated the effects of experiential and generative learning strategies on students' academic achievement, attitude to and practical skills in Biology in Oyo state. The study also examined the moderating effects of gender of the participants and their mental ability on their performance, attitude to and skills in ecology-related concepts in Biology.

The research design used was pretest-posttest control group, quasi-experimental design making use of a 3 x 2 x 3 factorial matrix.

Four hundred and twenty eight SS 1Biology students (197 males and 231 females) from nine purposefully selected intact classes participated in the study. The nine schools were randomly selected from three randomly selected local government areas of Oyo state. Four basic concepts were selected and used in the study. They are Pollution, Ecology, Conservation of natural resources and Population studies.

In order to collect data, eight instruments were used for the study. They are:

j. Students Biology Achievement Test (SBAT)

ii. Questionnaire on Students Attitude to Biology (QSAB)

iii. Biology Student Skills Rating Scale (BSSRS)

iv. Instructional Guide on Experiential Learning (IGEL)

v. Instructional Guide on Generative Learning (IGGL)

vi. Instructional Guide on Modified Conventional Strategy (IGMCS)

vii. Mental Ability Test (MAT)

viii. Evaluation Sheet for Assessing Teachers (ESAT) on:

(a) Experiential learning strategy,

(b) Generative learning strategy,

(c) Modified conventional strategy.

The study made use of the following work schedule:

Two (2) weeks were used for the training of research assistants.

One (1) week was used for the administration of pretest.

Eight (8) weeks were used for the treatment with the help of research assistants who administered the strategies on the students. The treatment took place at the same time in all the schools selected.

One (1) week (being the last week) was used for the administration of posttest. In all, the study lasted twelve weeks. Seven null hypotheses were raised and tested at 0.5 level of significance.

The collected data were analyzed using Analysis of Covariance (ANCOVA), Estimated Marginal Mean (EMM), Scheffe post-hoc analysis and finally graphs

Findings of this study are summarized below:

1 There was significant main effect of treatment on students' academic achievement in Biology. Students in the Experiential learning Strategy group had higher adjusted posttest achievement mean score than those exposed to the Generative learning strategy and those of modified conventional strategy group. Also in practical skills, students in the Experiential Learning strategy had higher adjusted posttest practical skills score than students exposed to Generative learning strategy and modified conventional strategy respectively. There was no significant main effect of treatment on students' posttest attitude to Biology

2 There was no significant main effect of gender on students' academic achievement, attitude to and practical skills in Biology.

3 There was significant main effect of mental ability on students' academic achievement in Biology. Students with high mental ability had the highest adjusted mean score ($\bar{x}$= 17.55); followed by students with medium mental ability ($\bar{x}$=16.30); while students with low mental ability had the least adjusted mean score ($\bar{x}$=13.58). However, the main effect of mental ability on students' attitude to and practical skills in Biology was not significant.

4 There was no significant interaction effect of treatment and gender on students' academic achievement in, attitude to and practical skills in Biology.

5 There was no significant interaction effect of treatment and mental ability on students' academic achievement in, attitude to and also on students' practical skills in Biology.

6 The interaction effect of gender and mental ability was not significant on student academic achievement in, attitude to and practical skills in Biology.

7 There was no significant three-way interaction effects of treatment, gender and mental ability on all the students' learning outcomes (which are students' academic achievement in Biology, students' attitude to Biology and students' practical skills in Biology).

5.2 Educational Implications

The use of the two active strategies (Experiential and Generative Learning Strategies) have been found to positively enhance the academic achievement of students in ecological concept and the acquisition of practical skills in Biology. Hence, the strategies were effective instructional strategies for improving performance of students in Biology. Students' involvement, in forms of experience and doing, is an important factor in the improvement of their performance and practical skills in Biology practical.

In view of the effectiveness of ELS and GLS, the two strategies should be incorporated into the teacher-education programmes in order to equip students and teachers of Biology with adequate instructional strategies that can make them effective students and teachers (Abimbola, 2013). Biology teachers should therefore stop using strategies that will not encourage students' active participation during instructional processes. Teachers of Biology should adopt the two strategies so as to improve students' motivation and learning in a collaborative environment through meaningful activities.

It can be seen from the study that there was no gender difference in students' academic achievement in ecology-related concepts when Experiential learning strategy and Generative learning strategy were used as instructional strategies. Whatever the gender, the strategies could help them equally.

Experiential learning strategy aims at encouraging Science students to be active recipients of knowledge and thereby learn by exploring their environment. The strategy supports learning by integrating theory with practice. With experiential learning strategy, students can be assisted to have concrete experience which is the first step, and make reflective observation based on the available materials for teaching which is the second step. Students also would be able to make abstract conceptualization and involve themselves in active experimentation and all these steps would lead them to new experiences.

With generative learning strategy, the steps involved (which are introductory phase, focusing phase, activity phase, discussion phase and application) would assist the students to have improved achievement as revealed and justified by the findings of this result.

With the use of both ELS and GLS, students were motivated and were quickly able to connect their already existing ideas on the subject matter. The two strategies were highly effective and useful to teach ecology, pollution, conservation of natural resources and population studies, which are mainly environmental concepts. These strategies gave students the opportunity to relate, interact and learn together. The learners were also assisted to overcome the tendency that some science concepts are difficult to learn.

The outcome of the study revealed a high level of performance among high mental ability students, those with medium mental ability performed moderately, while the students with low mental ability recorded low performance. The two strategies were so active and effective that even students with low mental ability could be assisted to have an enhanced improvement in their academic achievement and the acquisition of practical skills as revealed by their posttest mean scores.

5.3 Recommendations

From the findings of this study, the following recommendations are therefore made:

- Experiential learning strategy and the generative learning strategy should be adopted as effective and viable strategies for studying ecology, pollution, and conservation of natural resources as well as the population studies as the strategies improved students academic achievement and acquisition of practical skills needed in selected ecological-concept in the secondary schools.
- Experiential learning strategy supports learning by integrating theory with the practice. Hence, teachers of Biology should develop activities that will give room for learners to be active participants in the teaching and learning process in the Biology class.
- There is need to put into school Biology-curriculum, various activities that students can engage in, in the teaching of ecology-related concepts in Biology. Teachers should make their classroom teaching participatory where the learners are made to create their own experience through the materials involved and available in the environment.
- There should be organization of seminars and workshops for Biology teachers where the various steps involved in Experiential learning strategy and Generative learning strategy would be made known to them.
- It is recommended that Biology teachers should use Experiential learning strategy and Generative learning strategy as they are activity-based and students-centered, hence the quality and quantity of learning will be improved.
- Both strategies (Experiential learning and Generative learning) and their steps should be integrated into the school science curriculum so that the

teachers and would-be teachers can be trained in the use of the two strategies. This should not only be used for teaching ecology, pollution, conservation of natural resources and population studies, but should also be applied to other concepts in Biology. If this is done, more qualified biology students would be groomed and produced for biology-related courses in higher institutions of learning.

- The authors of biology texts should incorporate the various steps in Experiential learning strategy and Generative learning strategy in their texts so as to make them useful, relevant and more applicable to individuals, schools, interested groups and the larger societies.
- It is also recommended that Biology education researchers should replicate and improve upon this study by using the two strategies and conducting studies using larger sample size at other educational levels in the nation.

5.4 Conclusion

The experiential learning strategy and the generative learning strategy were effective at improving students' academic achievement in, and student acquisition of practical skills in Biology, because of the fact that both strategies were student-centred. The two strategies also encouraged active participation of students in mastering the concepts; therefore, the students were able to solve problems in Biology. Due to the fact that the learners were involved in different learning activities, they were able to identify misconceptions and made proper corrections.

Furthermore, the two strategies made teaching and learning flexible, promoted communication and cooperation towards effective learning among the students. Use of the two strategies, either singly or jointly, showed that students' academic achievement in, and practical skills in Biology (irrespective of gender) could be improved. The two strategies also encouraged students' participation in the classroom as they are learner-centred strategies.

5.5 Limitations of the study

In the course of conducting this study, some constraints were encountered and these might limit the generalization of the findings. Some of the limitations are:

1. The geographical scope of this study: The present study was conducted in only nine schools in just three randomly selected local government areas of Oyo state (Iseyin, Itesiwaju and Kajola). This calls for replication of the study among a larger population in the state in particular and in the nation at large.
2. Content scope: Only four selected ecology-related concepts were examined in the study. More other concepts could still be used.
3. Variable scope: Gender and mental ability were the only moderator variables used for this study. However, there are other variables such as income of the parents, parental educational background, school type, school location and so on. These could be explored.
4. Participant scope: Only four hundred and twenty eight students participated in the study.

5.6 Contributions of the Study to Knowledge

This study has contributed to knowledge generally in the following ways:

- Experiential learning model according to Kolb (1984) has four components but was modified to a model of seven in this study.
- Generative learning strategy which was adopted had five steps but was adapted and modified into seven steps in this study. This made the strategy more applicable to teaching in our own envinroment/culture here.
- Experiential learning strategy and generative learning strategy have been found to be effective at improving students' academic achievement in Biology and students' acquisition of practical skills, because of the fact that both strategies are student-centred.

This result has therefore provided a basis for curriculum innovation, training and in-service programmes for Biology teachers in the field as well as would-be biology teachers.

- Findings of this study have shown that the two strategies also encouraged active participation of students and mastery of the concepts; therefore, the students were able to solve problems in Biology. Due to the fact that the learners were involved in different learning activities, they were able to identify misconceptions and they therefore made proper corrections.
- Both strategies (Experiential learning and generative learning) made teaching and learning flexible, promoted effective communication and cooperation towards active learning among the students. The two strategies have also shown to have improved students' academic achievement and students' practical skills in Biology, irrespsctive of the influences of gender and mental ability.
- The Nigerian authors could also been exposed to the two strategies so that they can incorporate the steps into their texts and therefore make the teaching of biology easy. The various steps in both ELS and GLS can be incorporated thereby making the texts applicable to individuals, schools, interested groups and the larger societies.
- Findings of this study serve as part of the contributed efforts made by Nigerian educators to equip students to live effectively in this modern age of science and technology and to develop positive attitude towards the learning of Biology.

5.7 Suggestions for further studies

The following suggestions are made for further studies based on the fact that the researcher conducted this study only in three local government areas of Oyo state.

- The study could be replicated in secondary schools in other states of the country.
- The study could also be carried out in other subjects apart from Biology, using the same strategies.
- . Biology-education researchers may replicate and improve upon this study by conducting it among larger sample size, and at other educational levels in the nation.
- Other moderator variables such as school types, school location, numerical ability, socio-economic status of the parents, parental background, cognitive style and many more could also be introduced in other studies.
- Other aspects of Biology apart from ecological concepts could also be involved as this will improve the achievement of students in biological sciences.

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APPENDIX IA

BIOLOGY ACHIEVEMENT TEST (BAT)

INSTRUCTION: Answer all the questions

SECTION A: Personal Data

Name of School:

Name of Student: ……

Gender: Male ( ) Female ( )

Age: Below 15 Years ( ) 15 – 18 Years ( ) Above 18 Years ( )

Local Government: ……

School location: Urban () Rural ( )

SECTION B : Pick one option for a question

1. Which of the following is not a type of pollution?
   (a) air
   (b) wind
   (c) water
   (d) land
   (e) oil
2. Untreated sewage could be a pollution of water as well as
   (a) land
   (b) oil
   (c) water
   (d) wind
   (e) air
3. Electrical discharges in Air can introduce -------as an air pollutant
   (a) nitrogen oxides
   (b) dust particles
   (c) noise
   (d) chemical
   (e) fertilizers

4. Sewage as a land pollutant can be obtained from

(a) disused machine

(b) home and office

(c) soils and farms

(d) burning of coal

(e) School field

5. Thermal electric generating plants can produce one of the following as a pollutant of air

(a) herbicide

(b) glass

(c) organic matter

(d) crude oil

(e) heat to reduce the power of blood to carry oxygen

6. One of the following air pollutants combines with haemoglobin to form carboxyhaemoglobin

(a) sulphur dioxide

(b) carbon monoxide

(c) nitrogen oxide

(d) smoke

7. Creating conditions for complete combustion of fuels in internal combustion engines is a way of controlling --------pollution

(a) land

(b) water

(c) air

(d) vegetation

(e) oil

8. ----- -- is formed whenever fuel is burned incompletely

(a) carbon dioxide

(b) carbon monoxide

(c) nitrogen oxide

(d) nitrogen dioxide

(e) sulphur oxide

9. The motor vehicle exhaust is the main source of one of the following as a pollutant

(a) carbon dioxide

(b) nitrogen oxide

(c) carbon monoxide

(d) nitrogen dioxide

(e) carbon

10. Which one of the following is the danger of the overuse of pesticides and fertilizers on the ecosystem

(a) overpopulation

(b) under population

(C)water pollution

(d) accident

(e) sleeplessness

11. A constituent of the exhaust gases of motor vehicles which causes air pollution is

(a) water vapour

(b) oxygen

(c) ozone

(d) carbon dioxide

(e) carbon monoxide

12. Change in the environment that makes it undesirable for man to leave is
(a) ecosystem
(b) ecology
(c) genetics
(d) population
(e) pollution

13. We can reduce noise pollution by making ------- sound.
(a) useless
(b) serious
(c) meaningless
(d) less
(e) provocative

14. Land pollution due to the accumulation of solid wastes can be reduced by their proper collection and

(a) burning

(b) swallowing

(c) eating

(d) conservation

(e) disposal

15. Solid pollutants can damage ---------- causing the formation of smog and thereby affect weather
(a) air
(b) vegetation
(c) water
(d) oil
(e) animals

16. One of the following types of pollution cannot be controlled at the quaries, airports and factories

(a) air

(b)noise

(c) water

(d) land

(e) oil

17. To acquire a life long education and commitment to protecting the earth's environment is a function of

(a) the government
(b) lecturer
(c) individual
(d) The school

18. Conservation of air is the ------- and -------- of air so as to sustain life and improve heath and vitality

(a) destruction and preservation

(b) conservation and pollution

(c) pollution and destruction

(d) protection and preservation

19. The smoke from vehicles, machines, grinders, and burning tyres or firehood have ------- effect on human body

(a) positive

(b) adverse

(c)useful

(d) educational

20. Dumping of wastes should be in to the

(a) rivers

(b) dustbin

(c) environment

(d)school

21. Continuous felling of useful trees can cause

(a) money

(b) negative effect

(c) extinction

(d) pollution

22. The association between a host and the parasite is called

(a) predation

(b) parasitism

(c) ecology

(d) environment

23. Population increase can cause more -------- problem

(a) environmental

(b) school

(c) national

(d) state

24. A linear pattern of representation of the trophic interaction between a group of organisms belonging to different species living within an ecosystem is called a (a) food web

(b) food chain

(c) predation

(d) competition

25. Which of the following could be primary consumer?

(a) hawk

(b) pig

(c) tiger

(d) rat

APPENDIX IB

ANSWERS TO BIOLOGY ACHIEVEMENT TEST (BAT).

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

APPENDIX IIA

Questionnaire on Attitude to Biology (QAB)

INSTRUCTION: Answer all question

SECTION A: Personal Data

Name of School:……

Name of Student:……

Gender: Male ( ) Female ( )

Age: Below 15 Years ( ) 15 – 18 Years ( ) Above 18 Years ( )

Local Government:……

School Location: Urban ( ) Rural ( )

SECTION B

The following statements are developed to measure your attitude to biological science. Rate them, using SD, D, and SA as the case may be. Each of the items means

SD = Strongly disagree
D = Disagree
A = Agree
SA = Strongly Agree

S/N	Statement	SD	D	A	SA
1.	Biology is very interesting to me.				
2.	Biology is fascinating and fun.				
3.	Biology makes me feel secure, and at the same time is stimulating.				
4.	In general, I have a good feeling towards biology.				
5.	When I hear the word "biology", I have a feeling of dislike.				
6.	I approach biology with a feeling of hesitation.				
7.	I really like biology.				
8.	It makes me nervous to even think about doing a biology experiment.				
9.	I feel at comfortable in biology class.				
10.	I feel a definite positive reaction to biology; it's enjoyable.				
11.	My attitude to studying topics in environmental pollution is positive.				
12.	If the teacher gives the expected motivation one can learn better from environmental pollution topics.				
13.	The teaching of Biology as a subject needs motivation from the teacher				
14.	The teacher's attitude can affect my attitude towards science learning.				
15.	The teacher alone should not dominate the classroom teaching in Biology class.				
16.	Student's achievement is determined only by the teacher's action.				
17.	A student attitude to learning can be determined by the teachers attitude.				
18.	When a student is not taught but made to discover fact in biology, my attitude turns positive.				
19.	My attitude to biology becomes positive any time I am motivated.				
20.	I feel satisfied when biology is taught.				

APPENDIX III

BIOLOGY PRACTICAL SKILLS RATING SCALE (BSSRS)

This instrument is in two sections – A and B. A has to do with the personal data of the respondents while section B intends to rate the Students Practical Skills in Biology. The teacher is to rate the students in terms of observation, recording, measuring, classification drawing and labeling.

Section A: Personal Data

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

Section B:

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

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

APPENDIX IV

LESSON NOTES ON MODIFIED CONVENTIONAL METHOD

Lesson I

Subject: Biology

Aspect: Basic Ecological Concepts

Topic: Meaning and types of Ecology

Class: S.S.S. Two

Duration: 80 minutes

Refrences Books: (i) Ndu F.O.C, Asun P, and Aina J.O. (2001). Senior Secondary Biology for Senior Secondary Schools (New Edition) Text book Two, Longman Nigeria and (ii) S.O. Iloeje (2005). Senior Secondary Certificate Practical Biology Longman Nigeria. Pages 144 –149

Previous Knowledge: The students are very familiar with different plants and animals in the environment, and the interaction between them.

Instrumental Materials: The school football field and the laboratory with different species of plants and animals.

Specific Objectives: By the end of the lesson, the students should be able to

i. describe the term 'ecology'

ii. list and describe the types of ecology

iii. describe the various terms used in ecological concepts

iv. state and describe the local biomes in Nigeria.

Introduction: The teacher introduces the lesson by asking the students questions on their previous knowledge relating to the concept, ecology.

Presentation.

Step I: The teacher introduce the new concept, ecology.

Step II: The teacher presents the lesson by describing the term 'ecology'

Step III: He lists and describes the types of ecology

Step IV: The teacher describes the various terms used in ecological concepts

Step V: Evaluation**:** The teacher evaluates the lesson with the following questions

i. describe the term ‘ecology’

ii. list and describe the types of ecology

iii. describe at least five terms used in ecological concepts

iv. state and describe the local biomes in Nigeria

Step VI**:** Summary**:** The teacher brings all the points together to provide an overview of the concept discussed.

Step VII**:** Assignment**:** The teacher gives the following assignments to students, based on the next lesson

i. State the ecological concepts

ii. Enumerate five factors that can affect population

iii. State four methods of population studies

Summative evaluation:

LESSON NOTES ON MODIFIED CONVENTIONAL METHOD
Lesson II

Subject: Biology

Aspect: Basic Ecological System

Topics: Major Biomes of the world and Population Studies

Class: S.S.S Two

Duration: 80 minutes

References Books: (i) Ndu F.O.C, Asun P, and Aina J.O (2001). Senior Secondary Biology for Senior Secondary Schools (New Edition) Textbook Two, Longman Nigeria and (ii) S.O Iloeje (2005) Senior Secondary Certificate Practical Biology, Longman Nigeria. Pages 144 – 149.

Previous Knowledge**:** The students have been taught the ecological concepts and the local biomes in Nigeria.

Instructional Materials**:** A chart showing the various major biomes of the world and living organisms in the school compound.

Specific Objectives**:** By the end of the lesson, the students should be able to

i. enumerate the major biomes of the world
ii. describe each major biome and their various characteristics
iii. describe the population studies
iv. list and describe the factors that can affect population
v. State and describe the various methods of population studies

Introduction**:** The teacher introduces the lesson by reminding the students what they have been taught in the last class.

Presentation

Step I: The teacher states the new topic

Step II: The teacher enumerate the major biomes of the world

Step III: The teacher describes each major biomes and their various characteristics

Step IV: The teacher describes what is meant by population studies

Step V: The teacher lists and describes the factors that can affect population

Step VI: The teacher states the various methods of population studies

Step VII: The teacher describes the various methods of population studies

Evaluation**:** The teacher evaluates the lesson with the following questions

i. enumerate the major biomes of the world

ii. describe the biomes and their various characteristics

iii. describe what is meant by population studies

iv. list and describe the factors that can affect population

v. state and describe the various methods of population stuides

Summary**:** The teacher gives the summary of the whole lesson on the chalkboard, for the students to copy.

Assignment**:** Teacher gives the following assignments to the students against the next lesson.

i. State the ecological factors

ii. Enumerate five instruments for the measurements of ecological factors

iii. Describe the term, food chain

Summative evaluation**:**

LESSON NOTES ON MODIFIED CONVENTIONAL METHOD

Lesson III

Subject**:** Biology

Aspect**:** Basic Ecological Concepts

Topic**:** Ecological factors

Class**:** S.S.S Two

Duration**:** 80 minutes

References Books**:** Ndu F.O.C, Asun P and Aina J.O (2001). Senior Secondary Schools (New Edition). Textbook Two and (ii) S.O Iloeje (2005). Senior Secondary Certificate Practical. Longman Nigeria. Pages 146 – 149.

Previous Knowledge**:** The students have initially been taught what ecology is, its types and the major terms used in ecology.

Instructional Materials**:** Various living organisms (plants and animals) on the school field and the laboratory

Specific Objectives**:** At the end of the lesson, the students should be able to

i. describe the ecological factors

ii. put the ecological factors into major groups (Biotic and Abiotic)

iii. enumerate and describe the biotic ecological factors

iv. enumerate and describe the abiotic ecological factors

v. list and describe the factors common to both aquatic and terretrial habitats

Introduction**:** The teacher introduces the lesson by asking the students questions on ecology and its types; thereby reminding them all they have been taught on ecology.

Presentation**:**

Step I: The teacher introduces the new topic

Step II: The teacher presents the lesson on the ecological factors

Step III: The teacher puts the ecological factors into two major groups (Biotic and Abiotic)

Step IV: He enumerates and describes the biotic ecological factors

Step V: The teacher enumerates and describes the abiotic ecological factors

Step VI: The teacher lists the factors common to both aquatic and terrestrial habits

Step VII: The teacher describes the factors common to both aquatic and terrestrial habits

Evaluation**:** The teacher evaluates the lesson with the following questions

i. list and describe the ecological factors

ii. group the ecological factors into two state the groups

iii. enumerate and describe the abiotic ecological factors

iv. enumerate and describe the biotic ecological factors

v. list and desribe the factors common to both aquatic and terrestrial habitats

Step VII**:** Summary**:** The teacher gives the summary of the whole lesson on the chalkboard, for the students to copy.

Assignment**:** (i) What are the instruments for measuring ecological factors?

(ii) What do you understand by the term food chain?

Summative evaluation**:**

LESSON NOTES ON MODIFIED CONVENTIONAL METHOD

Lesson IV

Subject**:** Biology

Aspect**:** Basic Ecological Concepts

Topic**:** Measurement of ecological factors

Class**:** S.S.S Two

Duration**:** 80 minutes

References Books: (i) Ndu F.O.C, Asun P, and Aina J.O. (2001). Senior Secondary Biology for Senior Secondary Schools (New Edition) Text book Two, Longman Nigeria and (ii) Michael M.C (2008) Essential Biology for Senior Secondary Schools. Tonad Publishers Ltd. Pages 84 – 91.

Previous Knowledge**:** The students have initially been taught the various ecological factors.

Instructional Materials**:** Wind vane in the school compound and permanent quadrat.

Specific Objectives**:** At the end of the lesson, the students should be able to

i. enumerate the various instruments for the measurement of ecological factors
ii. describe the enumerated instruments
iii. describe the usage of each instrument for the measurement of the ecological factors

Introduction**:** The teacher introduces the lesson by reminding the students what they have earlier been taught on the ecological factors

Presentation

Step I: The teacher introduces the lesson by reminding the students their previous knowledge on the topic

Step II: The teacher presents the instruments normally used for measurement of ecological factors

Step III: The teacher enumerates the various instruments that can be used for the measurement of the ecological factors

Step IV: The teacher describes the enumerated instruments

Step V: The teacher describes the usage of the instruments one after the other, for the measurement of the ecological factors.

Step VI: The teacher evaluates the lesson with the following questions

i. enumerate at least eight instruments that can be used to measure ecological factors.

ii. describe the enumerated instruments

iii. describe how the instruments can be used to measure the ecological factors.

Step VII: The teacher gives the summary of the lesson in form of points on the chalkboard, for the students to copy.

Assignment**:** The following assignments are given by the teacher, against the next class.

i. State the components of an ecosystem

ii. List ten instruments of ecological factors. State the uses.

Summative evaluation**:**

LESSON NOTES ON MODIFIED CONVENTIONAL METHOD

Lesson V

Subject**:** Biology

Aspect**:** Basic Ecological Concepts

Topics**:** Functioning Ecosystem and Ecological Management

Class**:** S.S.S Two

Duration**:** 80 minutes

References Books**:** (i) Ndu F.O.C, Asun P, and Aina J.O (2001). Senior Secondary Biology for Senior Secondary Schools (New Edition) Textbook Two, Longman Nigeria and (ii) S.O Iloeje (2005) Senior Secondary Certificate Practical Biology, Longman Nigeria. Pages 144 –149.

Previous Knowledge**:** The students have initially been taught ecology, its types, general terms and the ecological factors.

Instructional Materials**:** Different types of living organisms like fowls, lizard, grasshoppers, grasses and trees in the school compound as well as preserved specimens in the laboratory.

Specific Objectives**:** At the end of the lesson, students should be able to

i. enumerate and describe the components of an ecosystem
ii. describe the concepts of food chain and food web
iii. describe the principles of energy transformation in nature
iv. describe nutrients cycling in nature

Introduction**:** The teacher introduces the lesson by reminding the students through questioning, their previous knowledge on ecology and ecological factors.

Presentation**:**

Step I: The teacher presents the new lesson to be considered

Step II: The teacher enumerates and describes the components of an ecosystem

Step III: He describes the concepts of food chain and food web

Step IV: The teacher describes the principles of energy transformation in nature

Step V: The teacher describes nutrient cycling in nature.

Step VI: The teacher evaluates the lesson with the following questions

i. enumerates and describe the components of an ecosystem

ii. describe the concepts of food chain and food web

iii. describe the principles of energy transformation in nature

iv. describe nutrient cycling in nature.

Step VII: The teacher brings all the points together on the chalkboard, for the students to copy.

Assignment**:** Teacher gives the following assignments to the students to do at home

i. Enumerate the components of an ecosystem

ii. What are the biological associations in nature? Describe them

Summative evaluation**:**

LESSON NOTES ON MODIFIED CONVENTIONAL METHOD

Lesson VI

Subject: Biology

Aspect: Biological Associations.

Topics: Biological Association in an Ecosystem

Class: S.S.S Two

Duration: 80 minutes

References Books: (i) Michael M.C. (2008). Essential Biology for Senior Secondary Schools. Tonad Publishers Ltd. Pages 91 – 93 and (ii) Senior Secondary Biology for Senior Secondary Schools by F.O.C Ndu, P. Asun and J.O Aina. Pupils Textbook One. Longman Nigeria.

Previous Knowledge: The students have initially been taught the components of an ecosystem, and the various reactions between the organisms.

Instructional Materials: A chart showing the feeding relationships between the organisms.

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

i. state and describe the types of associations in an ecosystem
ii. state relevant examples for each association
iii. describe what is tolerance
iv. describe the term 'adaption'
v. describe the adaptations of some plants and animals to their various environments

Introduction: The teacher introduces the lesson by reminding the students what they have been taught on the components of an ecosystem.

Presentation:

Step I: The teacher presents the topic for the new lesson

Step II: The teacher states and describes the types of association in an ecosystem

Step III: The teacher states relevant examples for each association

Step IV: The teacher describes what is meant by the term tolerance.

Step V: The teacher describes the term 'adaptation'

Step VI: The teacher describes the adaptations of some plants and animals to their immediate environment

Step VII: The teacher evaluates the lesson with the following questions

i. state and describe the types of association in an ecosystem

ii. state relevant examples for each association

iii. describe the term tolerance

iv. What is meant by the term 'adaptation'

v. describe the adaptations of some plants and animals to their immediate environment

Summary**:** The teacher brings all the points together on the chalkboard, for the students to copy.

Assignment**:** The teacher gives the following assignments to the students against the next class.

i. What is pollution? States the types.

ii. State three pollutants for each type.

Summative evaluation**:**

LESSON NOTES ON MODIFIED CONVENTIONAL METHOD

Lesson VII

Subject: Biology

Aspect: Pollution

Topics: Types, source and effects of pollution

Class: S.S.S Two

Duration: 80 minutes

References Books: (i) Senior Secondary Biology for Senior Secondary Schools by F.O.C Ndu, P. Asun and J.O Aina. Pupils Textbook One. Longman Nigeria and (ii) Michael M.C. (2008). Essential Biology for Senior Secondary Schools. Tonad Publishers Ltd. Pages 123 – 126

Previous Knowledge: The students have been taught pollution of environments while in Junior class.

Instructional Materials: A chart showing a cooking store with carbonmonoxide, a gas/air pollutant

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

i. give the definition of pollution

ii. state the types of pollution

iii. enumerate the pollutants, sources and effects of each type of pollution

iv. describe how each type of pollution can be controlled, one after the other

Introduction: The teacher introduces the lesson by a way of asking the students questions on pollution based on their initial knowledge.

Presentation.

Step I: The teacher states the topic of the lesson.

Step II: The teacher gives definition of pollution

Step III: The teacher states and describes the types of pollution

Step IV: The teachers enumerates the pollutants, the sources and effects of each type of pollution

Step V: The teacher describes how each type of pollution can be controlled, one after the other

Step VI: The teacher evaluates the lesson with the following questions

i. Define pollution

ii. State the types of pollution

iii. Enumerate the pollutants, sources and effects of each type of pollution

iv. Describe how each type of pollution can be controlled.

Summary**:** The teaches gives the chalkboard summary of the whole lesson, for the students to copy.

Assignment**:** Teacher gives the following assignments to the students against the next class.

i. What is pollution? State the types.

ii. What is meant by conservation of Natural Resources?

iii. Itemize at least four natural resources that can be conserved.

Summative evaluation**:**

LESSON NOTES ON MODIFIED CONVENTIONAL METHOD

Lesson VIII

Subject: Biology

Aspect: Conservation of Natural Resources

Topics: Conservation of Natural Resources

Class: S.S.S Two

Duration: 80 minutes

References Books: (i) Senior Secondary Biology for Senior Secondary Schools by F.O.C Ndu, P. Asun and J.O Aina. Pupils Textbook One. Longman Nigeria and (ii) Michael M.C. (2008). Essential Biology for Senior Secondary Schools. Tonad Publishers Ltd. Pages 126 – 131

Previous Knowledge: The students have been taught pollution – sources, effects and control. They are also familiar with different species of plants and animals that can be preserved and their uses.

Instructional Materials: A chart showing different species of organisms (plants and animals)

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

i. Describe what conservation of natural resources means

ii. Classify natural resources into renewable and non - renewable

iii. State the needs or reasons for conservation

iv. Describe the methods of Conserving Natural Resources

v. State and describe the ways of ensuring the conservation of natural resources

vi. State the problems and difficulties associated with conservation

Introduction: The teacher introduces the lesson by reminding the students what they have initially been taught on the pollution of environments and how to control it

Presentation**:**

Step I: The teacher states the new topic to be considered

Step II: He describes what conservation of natural resources means

Step III: He classifies the natural resources into renewable and non – renewable

Step IV: The teacher states the needs or reasons for the conservation of natural resources

Step V: The teacher describes the methods of conserving natural resources

Step VI: He states and describes the various ways of ensuring conservation of natural resources

Step VII: The teacher states the problems and difficulties associated with conservation of natural resources

Evaluation**:** The teacher evaluates the lesson with the following questions

(i) What is conservation of natural resources?

(ii) Classify the natural resources into two groups

(iii) State the needs or reasons for conserving natural resources

(iv) Describe the methods of conserving natural resources

(v) State and describe the various ways of ensuring conserving of natural resources.

Summary**:** The teacher gives the over-all summary of the whole lesson on the chalkboard, for the students to copy.

Asssignment**:** The teacher gives the following assignments to the students

(i) What are the reasons for conservation of natural resources?

(ii) Itemize six resources that can be conserved.

Summative evaluation**:**

APPENDIX V

LESSON NOTES ON EXPERIENTIAL LEARNING STRATEGY

LESSON I

TOPIC: Meaning and types of Ecology

Presentation

Step I: Introduction and grouping of students:

Students are divided into small groups, (grouping of the students)

Step II: Concrete experience: Presentation of materials:

Students follow instructions e.g. let each group observe the organisms (both plants and animals) on the field

Step III: Reflective observation

Students relay their previous experience. For example, it has been previously observed and taught that where organisms live in nature is called habitat

Step IV: Abstract conceptualization: acquisition of new knowledge:

Students are exposed to new learning or experience. E.g. students are made to see the interrelationship among organisms in an environment.

Step V: Active experience

Students ask questions based on the difference and similarities between their previous and their new experiences. E.g. Sir, initially we thought only the snakes can kill birds, are there birds that can also kill snakes?

Step VI: Conclusion and application:

Right and wrong conceptions are reconciled. Then, corrections are made.

Step VII: Summary:

Students make their jottings and then conclude

LESSON NOTES ON EXPERIENTIAL LEARNING STRATEGY

LESSON II

TOPIC: Major Biomes of the World and Population Studies

Presentation

Step I: Introduction and grouping of students:

Students are divided into small groups

Step II: Concrete experience: Presentation of materials:

Students follow instructions. For example, we shall work in groups. Each group should take a chart

a. Chart one containing diagrams of world biomes

b. Chart Two showing a members of a family

c. Chart Three showing a maternity centre

d. Chart four shows a corpse

Step III: Reflective observation

Students relay their previous experience. For example, what happens to the number of a family hen chart four is experienced.

Step IV: Abstract conceptualization: Acquisition of new knowledge:

Students are exposed to new experience. For example, if a plat of food is to be shared among four students continuously, what happens? This shows that it is not death alone that can reduce the population size etc

Step V: Active experience:

Students ask questions. E.g. what other factors can reduce or increase population size?

Step VI: Conclusion and application:

The students are guided to provide correct answers to the question raised. Right & wrong conceptions are reconciled.

Step VII: Summary:

Student make their jottings and then summit for making.

LESSON NOTES ON EXPERIENTIAL LEARNING STRATEGY

LESSON III

TOPIC: ECOLOGY FACTORS

Presentation

Step I: Introduction and grouping of students:

Students are divided into small groups

Step II: Concrete experience: Presentation of materials:

Students follow instructions. For example, A group should take an aquarium, take out its fish and observe the organism. Another group should converge under sun to observe the living organisms on the field. Another group in a dusty environment etc

Step III: Reflective observation

Students relay their previous experience on group basis

Step IV: Abstract conceptualization: Acquisition of new knowledge:

Students are exposed to new learning experiences through observation. For example, when even water is too much for an organism, it can become a limiting factor for it.

Step V: Active experience:

Students ask questions based on the differences and similarities between their initial and new knowledge. E.g. does it mean that not only too much sunlight can affect plants, that if there is no sunlight at all, plants can be negatively affected

Step VI: Conclusion and application:

Students are guided to provide correct answers to the questions raised

Step VII: Summary:

Students put down the corrections made.

LESSON NOTES ON EXPERIENTIAL LEARNING STRATEGY

LESSON IV

TOPIC: MEASUREMENTS OF ECOLOGICAL FACTORS

Presentation

Step I: Introduction and grouping of students:

Students are divided into small groups

Step II: Concrete experience: Presentations of materials:

Students follow instructions. E.g. Let each group take the provided instruments – tape, meter rule and dry thermometer

Step III: Reflective observation

Students relay their previous experience on the topic and the use of each instrument

Step IV: Abstract conceptualization: Acquisition of new materials:

Students are exposed to new learning or experiences through observation, measurements and manipulation of apparatus

Step V: Active experience:

Students ask questions based on the differences and similarities between previous and their new experiences e.g. apart form using thermometer to measure temperature in man, can we use it again for any other organism?

Step VI: Conclusion and application:

Right and wrong conceptions are reconciled, and the corrections are made.

Step VII: Summary:

Students put down notes as corrections are made.

LESSON NOTES ON EXPERIENTIAL LEARNING STRATEGY

LESSON V

TOPIC: FUNCTIONING ECOSYSTEM AND ECOLOGICAL MANAGEMENT

Presentation

Step I: Introduction and grouping of students:

Students are divided into small groups

Step II: Concrete experience: Presentation materials:

Students follow instructions. E.g let each group move to the school field and observe the feeding relationship between the organisms

Step III: Reflective observation

Student relay their previous experiences on their observation e.g. it is earlier known that some organisms will feed on others

Step IV: Abstract conceptualization: Acquisition of new knowledge:

Students are exposed to new learning experiences through observation.

Step V: Active experience:

Students ask questions based on the differences and similarities and their new experiences. E.g. what happens to the species of plants if they are continually fed upon by the rats and goats?

Step VI: Conclusion and application:

Right and wrong conceptions are reconciled.

Step VII: Summary:

Students put down notes, and the teacher marks.

LESSON NOTES ON EXPERIENTIAL LEARNING STRATEGY

LESSON VI

TOPIC: BIOLOGICAL ASSOCIATIONS IN AN ECOSYSTEM

Presentation

Step I: Introduction and grouping of students:

Students are divided into small groups

Step II: Concrete experience: Presentation of materials:

Students follow instructions. E.g. let each group observe how the lizards fight one another in the school. Another one is that each group should give a living cockroach before the fowl and see what happens

Step III: Reflective observation

Student relay their previous experience e.g. the fowls will always feed on the insects when sighted, and as well two rats will always fight for grasses and other food items.

Step IV: Abstract conceptualization: Acquisition of new knowledge:

Students are exposed to new learning e.g the fighting between two rats for food is called competition, it is an association etc.

Step V: Active experience:

Students ask questions based on the differences and similarities the previous and the new experiences e.g. will the eating of cockroaches by the fowls not put end to the existence of cockroaches?

Step VI: Conclusion and application:

Right and wrong conceptions are reconciled as corrections are made.

Step VII: Summary:

Students put down notes and the teacher marks.

LESSON NOTES ON EXPERIENTIAL LEARNING STRATEGY

LESSON VII

TOPIC: POLLUTION

Presentation

Step I: Introduction and grouping of students:

Students are divided into small groups.

Step II: Concrete experience: Presentation of materials:

Students follow instructions. For example, each group is provided dust particles and muddy water. Each group is also to take an insecticide (snipper) to work with.

Step III: Reflective observation

Students relay their previous experiences. For example, from the provided materials, what does their experience tell them will happen when those things are played with?

Step IV: Abstract conceptualization: Acquisition of new knowledge:

Students are exposed to new experience through manipulation of materials and observation. For example, they are to open the container of the snipper bottle and observe what happens to the air. They are also to put the muddy water into their drinking water etc.

Step V: Active experience:

Students ask questions based on their observations. E.g. is it only snipper that can render the air uncondusive? Etc

Step VI: Conclusion and application:

Right and wrong conceptions are reconciled and the corrections are made.

Step VII: Summary and assignments:

Students take assignment in groups

a. What happens to organisms in a river where fertilizer is poured?
b. Will a piece of land where cans of old vehicles are packed still be useful?

LESSON NOTES ON EXPERIENTIAL LEARNING STRATEGY

LESSON VIII

TOPIC: CONSERVATION OF NATURAL RESOURCES

Presentation

Step I: Introduction and grouping of students:

Students are divided into small groups

Step II: Concrete experience: Presentation of materials:

Students follow instructions. E.g each group should take the photographs. One contains a timber lorry with load; one is a picture of a poultry fully stocked.

Step III: Reflective observation

Students relay their previous experiences. E.g. some students will say, the timber lorry used to be chased by the government officials. Some will say birds/fowls are so previous and should be duly preserved etc.

Step IV: Abstract conceptualization: Acquisition of new knowledge:

Students are exposed to new learning experiences through observation and drawing of the shown species of organisms.

Step V: Active experience:

Students ask questions based on the differences and similarities between their previous and their new experiences. E.g.

- Is it fowls alone that should be preserved?
- Why are the timbers forbidden to be fell? etc

Step VI: Conclusion and application:

Right and wrong conceptions are reconciled.

Step VII: Summary:

Students put down notes as corrections are made.

APPENDIX VI

LESSON NOTES ON GENERATIVE LEARNING STRATEGY

LESSON 1

Topic: Meaning and types of Ecology

Presentation

Step 1: Introductory phase: Introduction and grouping of students:
Students are put into small groups

Step II: Focusing phase:
Students follow instructions. E.g.
Let each group observe the organisms on the field

Step III: Activity phase:
Students ask questions based on their observation e.g why are some organisms running from others? They then recall information and ideas from their memories.

Step IV: Discussion period:
Students record their observation

Step V: Application phase:
Students generate knowledge from their observation e.g they may be running from others probably because they may be eaten up.

Step VI: Conclusion
Representative from each group presents new knowledge to the entire class. E.g the one eating another one may be powerful than the one eaten.

Step VII: Summary:
Group differences are reconciled. E.g

LESSON NOTES ON GENERATIVE LEARNING STRATEGY

LESSON II

Topic: Major biomes of the world and population studies

Presentation

Step I: Introductory phase: Introduction and grouping of students:
Students are put into small groups

Step II: Focusing phase:
Students are given the measuring tapes to take measurement of the height of the trees.

Step III: Activity phase:
Students are exposed to unfavourable weather conditions e.g sun, excessive heat

Step IV: Discussion period:
Students ask questions e.g why are some plants taller than others? Are they not having the same conditions? Etc

Step V: Application phase:
Students generate knowledge from observation e.g weather conditions can determine whether the population will increase or decrease. Students record their observation e.g the uncondusive weather conditions can lead to death; when death occurs, the number of organisms in the environment decrease etc.

Step VI: Conclusion:
Representative from each presents new knowledge acquired

Step VII: Summary:
Group differences among the students opinion are reconciled.

LESSON NOTES ON GENERATIVE LEARNING STRATEGY

Lesson III

Topic: Ecological factors

Presentation

Step I: Introductory phase: Introduction and grouping of students:
Students are put into small groups

Step II: Focusing phase:
Students follow instructions. E.g let each group move to the football ground and observes the organisms there.

Step III: Activity phase:
Students ask questions based on their observations e.g why are some species of organisms more predominant in a place than other places, and why are some green plants more flourish than others in the same environment?

Step IV: Discussion period:
Students record observation

Step V: Application phase:
Students generate knowledge e.g the disparity in the growth of some plants might be due to some getting certain nutrients and some not getting; or some conditions might be very condusive while some might not.

Step VI: Conclusion
Representative from each group presents new knowledge from observation to the entire class.

Step VII: Summary:
Corrections are made and group differences are reconciled.

LESSON NOTES ON GENERATIVE LEARNING STRATEGY

Lesson IV

Topic: Measurement of ecological factors

Presentation

Step I: Introductory phase: Introduction and grouping of students:
Students are put into small groups

Step II: Focusing phase:
Students follow instructions.

a. Let one group take a dry thermometer, to measure the temperature of some biotic and abiotic factors

b. Another group to take a tape to measure the height and length of objectives

c. Another group, a meter rule etc

Step III: Activity phase:
Students manipulate apparatus, in groups and take measurements

Step IV: Discussion period:
Students ask question based on their observation and record the observation

Step V: Application phase:
Students generate knowledge in groups

Step VI: Conclusion
Representative of each group presents new knowledge acquired to the entire class

Step VII: Summary:
Group differences are reconciled as corrections are made

LESSON NOTES ON GENERATIVE LEARNING STRATEGY

Lesson V

Topic: Functioning Ecosystem and Ecological Management

Presentation

Step I: Introductory phase/Introduction and grouping of students:

Students are put into small groups

Step II: Focusing phase

Students follow instructions. E.g let us observe the organisms in the chart and list which one can eat another.

Step III: Activity phase:

Students observe different species of living organisms on the field and see how they interact with one another.

Step IV: Discussion period:

Students ask different questions from their observation

Step V: Application phase:

Students generate new knowledge from observation

Step VI: Conclusion

Representative of each group presents new knowledge acquired to the entire class.

Step VII: Summary:

Group differences are reconciled as corrections are made.

LESSON NOTES ON GENERATIVE LEARNING STRATEGY

Lesson VI

Topic: Biological Associations in An Ecosystem

Presentation

Step I: Introductory phase and grouping of students:

Students are put into small groups

Step II: Focusing phase:

Students follow instructions. E.g let all the students go to the football field and see what happens between an organism and the other

Step III: Activity phase:

Students ask questions based on their observation. For example, apart from organisms on the field, students are provided a dog with attaching tick to observe.

Step IV: Discussion period:

Students record observation e.g some students will say, the tick will be eaten by the dog, others will say, the tick is just living with the dog while few may guess the tick will be sucking from the dog etc.

Step V: Application phase:

Students generate knowledge from observation

Step VI: Conclusion:

Representative from each group presents new knowledge to the entire class.

Step VII: Summary:

Group differences are reconciled as corrections are made.

LESSON NOTES ON GENERATIVE LEARNING STRATEGY
Lesson VII

Topic: Pollution

Presentation

Step I: Introductory phase and grouping of students:
Students are put into small groups

Step II: Focusing phase:
Students follow instructions e.g let each group take a kerosene stove or Bunsen burner and a stick of matches

Step III: Activity phase:
Students manipulate apparatus e.g let each group put on the stove in the classroom with all the windows closed. Also each group should put a handful of mud into water inside the conical flask

Step IV: Discussion period:
Students record their observation after asking series of questions

Step V: Application phase:
Students generate knowledge from their observation. E.g the water becomes undrinkable etc

Step VI: Conclusion:
Representative from each group presents new knowledge to the class.

Step VII: Summary:
Group differences are reconciled as corrections are made.

LESSON NOTES ON GENERATIVE LEARNING STRATEGY
Lesson VIII

Topic: Conservation of Natural Resources

Presentation

Step I: Introductory phase and grouping of students:

Students are put into small groups

Step II: Focusing phase:

Students follow instructions. E.g each group observe the organisms/preserved specimens in the laboratory, and work on the following questions.

-how many of them are beneficial to man?

-what should be done to them to always have them?

-for what other reasons should they be preserved at all?

Step III: Activity phase:

Students manipulate apparatus. For example, let each group take a knife to kill one of the fowls provided.

Step IV: Discussion period:

Students ask questions from their observation. E.g

(i) What will likely happen if we continue to kill all the fowls?

(ii) Who are the people that should be responsible for keeping these fowls?

Step V: Application phase:

Students generate new knowledge e.g these birds are so precious and should be preserved; some people or agencies should be responsible for the preservation etc.

Step VI: Conclusion

Representative from each group presents new knowledge and group differences are reconciled as corrections are made.

Step VII: Summary:

The students put down notes and the teacher checks.

APPENDIX VIIA

MENTAL ABILITY TEST (MAT)

SOURCE: AUSTRALIAN COUNCIL FOR EDUCATIONAL RESEARCH (ACER) TEST

Name: ……

School: ……

Gender: ……..……

(Male/Female):----------

Age Now:……

Class: ……

Date of Test: ……

This is a test to see how you can think. It contains questions of different kinds. Some examples and practice questions will be given to show you how to answer the questions.

Example A:

Question 1:

Find out how the following numbers go. Write the missing numbers in the brackets:

2 5 8 - 14 17 - 23 (11 & 20)

Question 2:

Find out how the following numbers go. Write the missing numbers in the brackets:

4 3 6 5 - 7 10 - (8 & 9)

Question 3:

Find out how the following numbers go. Write the missing numbers in the brackets:

1 3 5 7 - 11 - 15 (9 & 13)

Question 4:
Find out how the following numbers go. Write the missing numbers in the brackets:
26 23 20 17 14 - 8 - (11 & 5)

Example B:

Question 5:

Find the number which should be in the square with the question mark and write it in the brackets:

3	5	7
6	8	10
9	11	?

(13)

Question 6:

In this table two numbers are missing. Find the number which should be in the square with the question mark and write it in the brackets:

2	5	7
6	-	10
11	14	?

(18)

Question 7:

Find the number which should be in the square with the question mark and write it in the brackets:

1	3	5
3	-	7
5	7	?

(9)

Question 8:

Find the number which should be in the square with the question mark and write it in the brackets:

17	13	9
15	11	?
9	-	1

(7)

You will have 20 minutes to do the test. Some questions are easier than others. Try each question as to come to it, but if you find any question is too hard, leave it out and come back to it later if you have time. Do not spend too much time on any one question. Try to get as much right as possible. DO NOT TURN THE PAGE OVER UNTIL YOU ARE TOLD.

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1. Find out how the following numbers go. Write the missing numbers in the brackets.

   1 5 - 13 - 21 25 29 - ( )

2. What change should 1 get from ₦10 note if I buy two theatre tickets at ₦2.50 each ( )

3. Find the number which should be in the square with the question mark and write it in the brackets:

2	1	5
7	6	-
12	?	15

( )

4. Find out how the following numbers go. Write the missing numbers in the brackets.

19 9 18 8 - 7 16 - - ( )

5. Sola is three times as old as his sister Yemi. Their father, who is 85, is seven times as old as Yemi. How old is Sola?

6. Find the number which should be in the square with the question mark and write it in the brackets:

6	10	17
8	-	19
12	16	?

( )

7. Find out how the following numbers go. Write the missing numbers in the brackets.

512 256 128 64 - 16 - 4 ( )

8. Which one of the following prices for oranges is the cheapest?

a. 3k each

b. 27k per dozen

c. 5 for 12k

d. 8 for 18k

e. 8 for 6k

9. Find the number which should be in the question mark and write it in the brackets:

32	8	2
-	16	4
96	24	?

( )

10. Find out how the following numbers go. Write the missing numbers in the brackets.

87 78 76 67 - 58 54 ( )

11. The total cost of ten books bound in leather is ₦ 200. Each book in ordinary edition cost ₦10. How much extra do I pay on each book for the leather binding? ( )

12. Find the number which should be in the square with the question mark and write it in the brackets:

2	4	8
6	-	24
8	36	?

( )

13. John and Mary are twins whose ages together are half their mother's. Their father who is three years older than their mother is 51. How old is John?( )

14. Find the number which should be in the square with the question mark and write it in the brackets:

1	3	9
2	-	10
5	7	?

( )

15. It took me four times as long to climb mountain 6,000 metres high as it took me come down. I descended 6,000 metres in an hour. How many hours did it take to climb up? ( )

16. Find the number which should be in the square with the question mark and write it in the brackets:

1	-	9
4	12	36
?	48	144

( )

17. What are two numbers whose sum is 16 such that the first divided by the second gives three?

( )

18. Find out how the following numbers go. Write the missing numbers in the brackets.

0 - 3 5 6 8 - 11 ( )

19. Find the number which should be in the square with the question mark and write it in the brackets:

13	9	5
7	5	?
1	-	1

20. Find out how the following numbers go. Write the missing numbers in the brackets.

4 8 7 - 13 26 - 50 ( )

21. If nine framed pictures cost ₦130.50 and each picture unframed only cost one third as much, how many unframed pictures could I buy for the same money? ( )

22. Find the number which should be in the square with the question mark and write it in the brackets:

13	9	5
7	5	?
1	-	1

( )

23. Find out how the following numbers go. Write the missing numbers in the brackets.

1 3 - - 81 243 729 ( )

24. I bought an equal number of 6k magazines and $2^{1}/_{2}$k exercise books which cost me 45k together. How many of each did I buy? ( )

25. Find out how the following numbers go. Write the missing numbers in the brackets.

41 35 30 26 - 21 - 20 ( )

26. A greengrocer finds that by selling at 40k per kilogram, he makes exactly the same profit as by selling as 30k per bunch. What is the average weight of each bunch of his carrot? ( )

27. A furniture dealer bought some chairs at ₦48 per dozen. In selling them he received as much as two chairs as he had paid for three chairs. What was the selling price per dozen? ( )

28. Find the number which should be in the square with the question mark and write it in the brackets:

18	3	6
2	-	2
9	3	?

( )

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29. I can buy 5 grams of potatoes for ₦20.90. How much do I pay for $^1/_2$ gram? ( )

30. In a class of 48 pupils there are 8 more boys than girls. How many boys are there? ( )

31. Find the number which should be in the square with the question mark and write it in the brackets:

-	1	8
18	2	?
27	-	24

( )

32. Three new books cost 45k, 90k and ₦1.05 respectively. If I buy them second hand I only pay two third of the new price. How much do I save? ( )

33. A piece of wood 35 centimeters long is to be cut in three parts, each successive part being twice as long as the previous part. What is the length of the longest part? ( )

34. A kitten is three days old a puppy is 11 days old. How many days will puppy be twice as old as the kitten? ( )

35. A dairy serves mixture of two parts cream and three parts milk. How many pints of cream will it take to make 15 pints of the mixture? ( )

36. Find out how the following numbers go. Write the missing numbers in the brackets.

87 74 63 54 47 - 39 - (&)

APPENDIX VIIB

MENTAL ABILITY TEST (MAT)

SOURCE: AUSTRALIAN COUNCIL FOR EDUCATIONAL RESEARCH (ACER)

HIGHER TEST

Name: …… Age now: ……

(SURNAME BLOCK LETTERS) Gender: ……

Date of Test: ……

School: …… Class: ……

This is a test to see how well you can think. It contains questions of different kinds. Some examples and practice questions will be given to show you how to answer the questions.

EXAMPLE A: Four of the following are alike in some way. Write the numbers of the other two in the brackets at the end of the line.

(1) Tea (2) Coffee; (3) Shoes; (4) Cocoa; (5) Pencil; (6) Milk

(3 & 5) (Shoes and pencil)

Question 1: Four of the following are alike in some way. Write the numbers of the other two in the brackets.

(1) Apple (2) pear (3) potato (4) banana (5) carrot (6) orange

(3 & 5) (potato & carrot)

Question 2: Four of the following are alike in some way. Write the numbers of the other two in the brackets.

(1) Door (2) window (3) coat (4) wall (5) roof (6) book (3 & 6) (coat & book)

EXAMPLES B: TOWEL is to WATER AS BLOTTING PAPER is to

(1) School (2) ink (3) writing (4) desk (5) pen (ink) 2

Question 3: NEWSPAPER is to SEE as WIRELESS is to

(1) Write (2) hear (3) dial (4) ear (5) deaf (hear) 2

EXAMPLE C: Which two of the following statements mean most nearly the same?

(1) Two many cocks spoil the broth

(2) Make hay while the sun shines

(3) A stitch in times saves nine

(4) It's a long lane that has no turning

(5) Strike while the iron is hot (2 & 5)

Question 4: Which two of the following statements means most nearly the same?

(1) A careless master makes a negligent servant

(2) To resist him that is set in authority is evil

(3) Little is done when many command

(4) When the eat is away the mice do play

(5) Where there are seven shepherds there is no flock (3 & 5)

Question 5: Which two of the following statements together prove that **"OUR DOG BIT THE POSTMAN YESTERDAY"?**

(1) Our dog is the only Alsatian in the street

(2) The postman was late yesterday

(3) The postman is in bed because an Alsatian bit him yesterday

(4) Dogs seem to dislike postmen

(5) The postman had a sore leg last week (2 & 4)

You will have 15 minutes to do the test. Some questions are easier than others. Try each questions as you come to it but if you find any question is too hard, leave it out and come back to it later if you have time.

Do not spend too much time on any one question.

Try to get as many rights as possible.

DO NOT TURN THE PAGE OVER UNTIL YOU ARE TOLD.

1. Four of the following are alike in some way. Write the numbers of the other two in the brackets.

   (1) Table (2) chair (3) man (4) bed (5) cupboard (6) towel ( )

2. FILTH is to DISEASE as CLEAN is to

   (1) Dirty (2) chair (3) water (4) illness (5) health ( )

3. Four of the following are alike in some way. Write the numbers of the other two in the brackets

(1) Tube (2) artery (3) tunnel (4) string (5) wire (6) rope ( )

4. INCH is to SPACE as SECOND is to

(1) Hour (2) age (3) time (4) clock (5) third ( )

5. Four of following are alike in some way. While the numbers of the other two in the brackets.

(1) Lagoon (2) pool (3) swamp (4) lake (5) marsh (6) pond (&)

6. PIN is to HEAD, NEEDLE is to

(1) Pick (2) sew (3) eye (4) point (5) thread ( )

7. Four of the following are alike in some way. Write the numbers of the other two in the brackets.

(1) Onlooker (2) spectator (3) critic (4) eye-witness (5) author (6) bystander ()

8. HEAT is to ASHES as CARPENTARY is to

(1) Carpenter (2) sawdust (3) chisel (4) furniture (5) wood ( )

9. Four of the following are alike in some way. Write the numbers of the other two in the brackets

(1) Sponge (2) water (3) map (4) towel (5) blotting-paper (6) dirt ( )

10. Which two of the following statements mean most nearly the same?

(1) Time is a herb that cures all diseases

(2) Anticipation is better than realization

(3) To-day is worth two tomorrow

(4) To spend today is to be set back tomorrow

(5) There is no time like the present ( )

11. TELEPHONE is to VOICE as LETTER is to

(1) stamp (2) post-office (3) writing (4) correspondence (5) envelope ( )

12. Which two statements prove “JOHN IS A GOOD SWIMMER”?

(1) Bob goes to the baths everyday

(2) John and Bob are friends

(3) Bob won last year’s swimming championship

(4) John beat Bob in a race last week

(5) John has challenged Bob to a race ( )

13. MANNERS are to POLITE as MORALS are to:

(1) Politics (2) politeness (3) wealthy (4) virtuous (5) strong ( )

14. Which two statements prove that "MR. SMITH OWNS SOME TAMWORTHS"?

(1) Tamworths are better pigs than Berkshires

(2) One-eight of the pigs in that pen are Tanworths

(3) Most of the pigs in that pen are Berkshires

(4) At the pigs in that pen belong Mr. Smith

(5) Most of the farmers in the distinct own Tamworths ( )

15. Four of the following are alike some way. Write the numbers of the other two in the brackets

(1) Spire (2) church (3) flagpole (4) steeple (5) tower (6) hall ( )

16. OCEAN is to LAKE as CONTINENT is to:

(1) river (2) land (3) mountain (4) Island (5) Europe ( )

GO STRAIGHT ON WITH THE NEXT PAGE

17. Which two of the following statements mean most nearly the same?

(1) Fire that's closest kept burns fiercest

(2) Set a thief to catch a thief

(3) A dog with a bone knows no friend

(4) Fight fine with fire

(5) Sow the wind, reap the whirlwind ( )

18. Three days in the week have the same number of letters. In the brackets write the first letter of the day which of the three comes first in the alphabet. ( )

19. "ONLY PREFECTS WEAR A BADGE" ALL PREFECTS ARE IN FORMS VI"

Therefore, which one of the following statements is true? Write its number in the brackets

(1) All Form VI boys may wear a badge

(2) A boy wearing a badge is in Form VI

(3) All 1st XI boys may wear badges

(4) V Form Prefects do not wear badges

20. Four of the following are alike in some way. Write the numbers of the other two in the brackets.

(1) blame (2) accuse (3) indiet (4) loath (5) censure (6) ape ( )

21. Which of the following statements mean most nearly the same?

(1) He who follows two hares will catch neither

(2) To blow and swallow at the same time is not easy

(3) He holds nothing fast who grasps at too much

(4) Despise the man who blow hot and cold with the same breath

(5) It is easy to despite what you cannot obtain ( )

22. FEW is to MANY as OCCASIONALLY is to:

(1) seldom (2) never (3) every (4) often (5) always ( )

23. Four of the following are alike in some way. Write the numbers of the other two in the brackets.

(1) corrugated (2) involved (3) complicated (4) intricate (5) coarse (6) complete ( )

24. Which two of the following statements together prove that

"MR. REED DOES NOT LIVE IN HUME STREET"

(1) All the buildings in Hume Street are modern

(2) All the in Hume Street are flats

(3) Mr. Reed lives in comfort

(4) Mr. Reed does not live in a flat

(5) Mr. Reed lives five miles from town

25. If these words were rearranged correctly to form a sentence with what letter would be middle word begins? Is From a Molchill a Mountain a Thing Different ()

26. GATE is to FENCE as PORT is to:

(1) land (2) coast (3) town (4) sea (5) destination ( )

27. Which two of the following statements mean most nearly the same?

(1) It's petty expenses that empty the purse

(2) Small gains bring riches in

(3) Even the weak are strong when united

(4) Constant dripping wears away the stone

(5) A chain is as strong as its weakest link ( )

28. Four of the following are alike in some way. Write the numbers of the other two in the brackets.

(1) ruler (2) heat (3) clock (4) thermometer (5) rain gauge (6) yard ( )

29. Which two of the statements mean most nearly the same?

(1) Repentance is poor consolation

(2) More haste less speed

(3) Quick decisions often breed regret

(4) He'll have a bucket of tears for joy

(5) Marry in haste, repent in leisure ( )

30. DRAMATIST is to PLAY as COMPOSER is to:

(1) orchestra (2) plano (3) symphony (4) performance (5) concert ( )

31. Which two of the following statements together prove that "TODAY is COLDER THAN YESTERDAY"?

(1) Every Friday this month was cold day

(2) To-morrow is the first day of the month

(3) Last Thursday was a hot day

(4) The last of each month this year has been the coldest day in the month

(5) Summer is nearly over

32. Four of the following are alike in some way. Write the numbers of the other two in the brackets.

(1) fugitive (2) enemy (3) evacuee (4) escapee (5) prisoner (6) truant ( )

33. Which two of the following statements mean most nearly the same?

(1) A great fortune is a great slavery

(2) Better beans and bacon in freedom than cakes and ale in bondage

(3) Put a chain round the neck of a slave and the end fasters round your own

(4) Lean liberty is better than fat slavery

(5) Stone walls do not a prison make ( )

34. In a certain code the English word BOARD is writer CODVL. What would be English word BAD be in the code?

35. Which two of the following statements mean most nearly the same?

(1) Forewarned is forearmed

(2) The loss which is unknown is no loss at all

(3) No man is happy that does not think so

(4) Uneasy lies the head that wears a crown

(5) Where ignorance is bliss, it is folly to be wise

36. BATTLE is to DUEL as CHORUS is to:

(1) twins (2) duet (3) selection (4) music (5) song

APPENDIX VIII

EVALUATION SHEET FOR ASSESSING TEACHERS ON EXPERIENTIAL LEARNING STRATEGY (ESATELS)

Name of School:……

Local Government Area:……

VG = Very Good

G = Good

AV = Average

P = Poor

VP = Very Poor

This instrument was designed to evaluate the research assistants already trained for the study.

S/N	Statement	V G5	G 4	A V3	P 2	VP 1
1.	Introduction and grouping of students					
2.	Concrete experience: Presentation of materials. Students follow instructions.					
3.	Reflective observation: Students relay their previous experience on each concept/topic					
4.	Abstract conceptualization: Students are exposed to new learning or experience					
5.	Active experience: Students ask question based on the differences and similarities between their previous and their new experiences.					
6.	Conclusion and application					
7.	Summary: Students put down notes.					

APPENDIX IX

EVALUATION SHEET FOR ASSESSING TEACHERS ON GENERATIVE LEARNING STRATEGY (ESATGLS)

Name of School:……

Local Government Area:……

VG = Very Good

G = Good

AV = Average

P = Poor

VP = Very Poor

S/N	Statement	V G5	G 4	A V3	P 2	VP 1
1.	Introductory phase:Students are put into small groups.					
2.	Focusing phase:Students follow instructions					
3.	Activity phase:Students manipulate apparatus					
4.	Discussion period:Students ask questions based on their observations					
5.	Application phase: Students generate knowledge from observations					
6.	Conclusion: Representative from each group presents new knowledge to the entire class..					
7.	Summary					

APPENDIX X

EVALUATION SHEET FOR ASSESSING TEACHERS ON MODIFIED CONVENTIONAL STRATEGY (ESATMCS)

Name of School:……

Local Government Area:……

VG = Very Good

G = Good

AV = Average

P = Poor

VP = Very Poor

S/N	Statement	V G5	G 4	A V3	P 2	VP 1
1.	Introduction of the new concept by the teacher.					
2.	Presentation of the lesson by the teacher.					
3.	Formative evaluation stage with questions.					
4.	The teacher gives the summary of the whole lesson on the chalkboard.					
5.	Conclusion: The teacher allows the students to copy the summary, then marks the learner's notes					
6.	Application stage					
7.	Assignments:The teacher gives the students homework/assignment					

APPENDIX XI

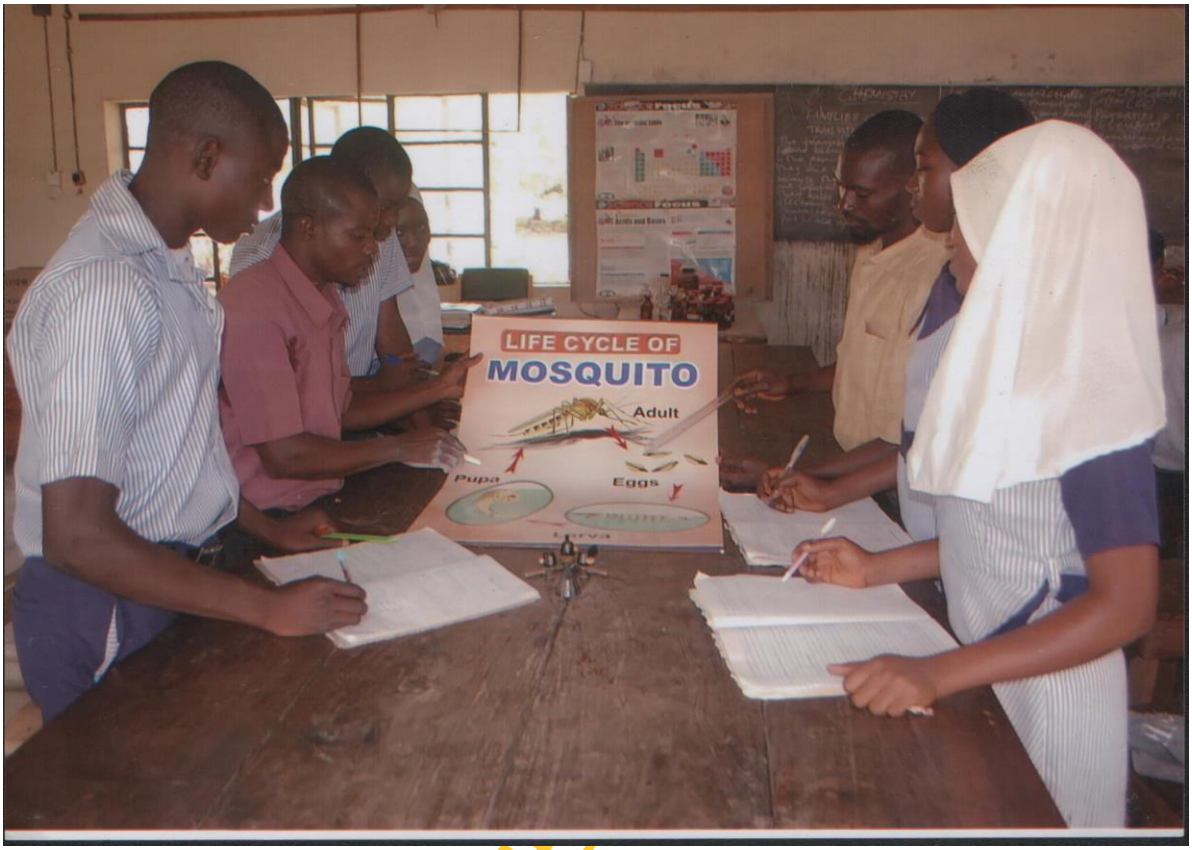
LIST OF SCHOOLS USED

10. Ismog Community Grammar School, Okeho- Kajola Local Government (ELS 1)
11. Otu Community Grammar School, Otu – Itesiwaju Local Government (ELS 2)
12. St. Johns Catholic High School, Iseyin – Iseyin Local Government (ELS 3)
13. A.D.S Grammar School, Okeho - Kajola Local Government (GLS 1)
14. Okaka Community Grammar School, Okaka - Itesiwaju Local Government (GLS 2)
15. Ekunle Grammar School, Iseyin - Iseyin Local Government (GLS 3)
16. Baptist High School, Ilero - Kajola Local Government (MCS 1)
17. Ipapo Community Grammar School, Ipapo- Itesiwaju Local Government (MCS 2)
18. Baptist Secondary Grammar School, Iseyin- Iseyin Local Government (MCS 3)

The Reseracher with some of the reserach Assistants

Generative Learning Strategy

Generative Learning Strategy



Expirential Learning Strategy

Modified Conventional Strategy

Modified Conventional Strategy

Experiential Learning Strategy

Generative Learning Strategy

Generative Learning Strategy

Generative Learning Strategy

Expirential Learning Strategy

Experential Learning Strategy

Experential Learning Strategy

Experential Learning Strategy