EFFECTS OF GUIDED-DISCOVERY AND SELF-LEARNING STRATEGIES ON SENIOR SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN BIOLOGY

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ABSTRACT

The traditional instructional strategy employed by most biology teachers in teaching Biology concept has resulted in low learning outcomes. There is need to employ strategies such as guided discovery and self learning, particularly, among secondary schools students. The two strategies have been proved in literature to have exposed students to a better response to life changes in the real world; needed in alleviating the problem of low students' achievement in biology, but they have not been adopted in the teaching of biology concepts. This study, therefore, examined the effects of guided discovery (GD) and self-learning (SL) strategies on senior secondary school students' achievement in biology. The pretest-posttest control group quasi-experimental design with 3x2x2 factorial matrix was adopted. Two hundred and forty (240) SS2 students from six purposively selected senior secondary schools in two local government areas of Oyo State were used for the study. The schools were randomly assigned to experimental (GD and SL) and control (CS) groups and the study lasted for fourteen weeks. Six instruments used were: Teachers Instructional Guides for teachers using the two treatments and control group; Students Environmental Achievement Test (r=0.80), Cognitive Style Test (test-retest r=0.81) and Assessment Sheet for evaluating research assistants. Three null hypotheses were tested at 0.05 level of significance. Data were analysed using ANCOVA and Scheffe post hoc test. Treatment had significant main effect on students' achievement score ($F_{(2,227)} = 197.804; p < 0.05$). SL enhanced achievement scores ($\bar{x} = 14.59$) than GD ($\bar{x} = 14.20$) and CS ($\bar{x} = 12.53$). Self learning and guided discovery strategies improved students' achievement in biology. It is, therefore, recommended that teachers, curriculum developers and textbook writers adopt these two strategies for the improvement of students' learning outcomes in biology.

Keyword: Guided-Discovery, Self-Learning, Science, Biology.

Reference to this paper should be made as follows: Akanbi, A.A. and Kolawole, C.B. (2014), Effects of Guided-Discovery and Self-Learning Strategies on Senior Secondary School Students' Achievement in Biology. *J. of Education and Leadership Development,* Vol. 6, No. 1, Pp. 19 – 42.

Introduction

Science is a systematic method of continuing investigation, based on observation, scientific hypothesis testing, measurement, experimentation and theory building phenomena, processes that are open to further testing, revision, falsification are accepted or rejected on the basis of scientific evidence. According to Alebiosu, (2003) science aimed at searching for causes and providing reasons for solution to

phenomena or experiences in life. Generally speaking science is a way of life. Oyewole, (2003) explained that some people view science as a means or instrument for technical and economic development of a nation. Others see Science as a combination of some school subjects like Mathematics, Chemistry, Physics, Biology, Geology etc. Science can be termed as a method of solving problems, a part of man's culture, an aspect of human activity, a body of knowledge about the universe; etc. Obioma, (2008) declared that every learner who has gone through nine years of basic education should have acquired appropriate levels of literacy, numeracy, manipulative, communicative and life skill, as ethical, moral and civic values needed for laying solid foundation for life-long learning as a basic for scientific and reflective thinking.

Biology plays a key role in industrialization and other sectors of the economy. Biology is a practical based subject, which equips students with concepts and skills that are useful in solving the day-to-day problems of life. The study of Biology aims at providing the learner with the necessary knowledge with which to control or change the environment for the benefit of an individual, family or community. In general, the importance of Biology to humanity can be outlined as follows:

- The learning of Biology helps us to know how to use natural resources more efficiently in industry e.g. in bio-technology, food production, building and textile and paper industries.
- The learning of Biology helps us to understand changes in the environment and the factors affecting these changes, in order to know how human needs are influenced.
- The learning of Biology is important in helping mankind to find effective ways of preventing, treating and curing diseases and home management techniques e.g. better methods of food preservation, efficient food preparation and care of the family.
- The learning of Biology is important in helping the improvement of agricultural yields through scientific innovations.

Having enumerated the importance of Biology to the society, there is no doubt about its immense contribution to the economic growth and developments of the country. The teaching and learning situation of Biology in Nigeria has been faced with many problems as it's applicable to all science subjects in the school curriculum. The federal government of Nigeria has taken a good number of measures in the previous years to improve and promote the study of science, technology and mathematics in the country. This is evident in her effort in establishing more special science secondary schools to facilitate the teaching and learning of sciences

(including Biology). Over the years, experts have continued to draw attention to the grave consequences of constant decline in the performance of our secondary school students in science subjects especially in public examination such as National Examination Council and West African Senior Secondary Certificate Examination Ogunleye, (2002). This is corroborated by Abimbola, (2013) that the performance level for science subjects did not show any significant rise for a twenty-year period between 1991 to 2011 and confirmed that candidates performance in Biology over those years never rose above 50% perhaps because non science students use to register for Biology as a core science subject. The analysis of Senior Secondary Certificate Examination result in Table 1 below made available from the West African Examination Council (WAEC) statistics unit on enrolment of students and their performance in Biology revealed the enormity of this problem.

Table 1: Percentage Distribution of Students' Performance in May/June Senior Secondary Certificate (SSCE) in Biology in Nigeria: 2002 - 2012

Year	Total Entry	Total Sat	Credit Passes 1-6	Percentage Passes
	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	1,170,522	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

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

From table 1, the number of percentage credit passes and above in Biology continues to fall below 50% for the period of eleven years reviewed, although grade 7 and 8 are considered to be Passes but these are not good enough for candidates gaining admission into tertiary institutions. The table presented in Figure 1 shows the interpretation of table 1.

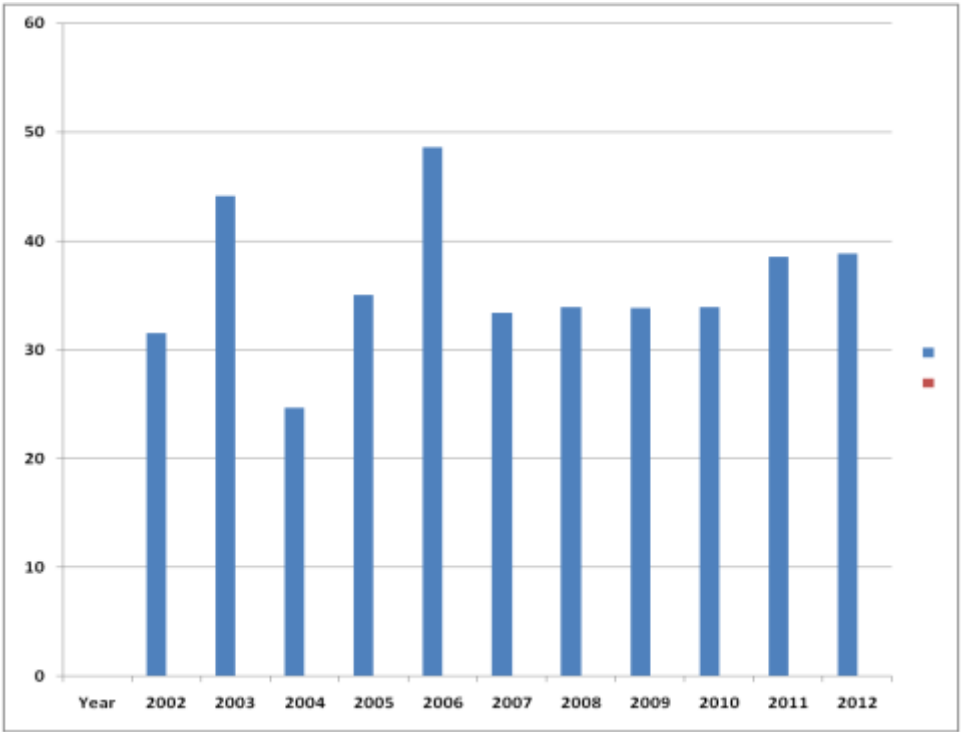

Figure 1: Bar Chart Showing Percentage Credit Passes of Students' Performance in May/June Senior Secondary Certificate Examinations (SSCE) in Biology in Nigeria: 2002 – 2012

Despite all efforts to improve students' performance in Biology, it has been observed, unfortunately, that the educational system is to a great extent not achieving its predetermined goals and objectives due to high failure in public examination such as the Senior Secondary Certificate Examination (Ndioho, 2007). The percentage passes for the year 2002 to 2012 are not good enough especially for candidates that want to study Biological Sciences and Biology based courses or for any candidate that may include Biology as one of the relevant five subjects, passed at credit level in order to be admitted into any higher institution in Nigeria. As seen in the admission rate between 1995/1996 academic session and 2007/2008 academic session has been slow in improving as stated by (Jekayinfa, Yusuf, Yahaya & Yusuf, 2010) and supported by Abimbola, (2013) who concluded that the percentage of candidates admitted did not reach 20 percent during this period, except 1998/1999 academic session when it was 23.09 percent.

Isa, (2007) while citing from WAEC chief examiners reports maintained that students' performance in Biology is poor despite the fact that several crucial efforts have continually been made over the years to remedy the yearly poor performance and also to improve students' performance. Akinola, (2006) believed that the causes of mass failure of students in senior Biology examination include teacher's methodology, structuring of the curriculum, the concentration of examination

questions on few topics and the inability of students to perform enough practical before examination.

In teaching toward understanding of major concepts in Biology and achieving conceptual change in students learning outcome, it is first necessary to understand student's prior knowledge, examine it, identify confusions, and then provide opportunities for old and new ideas to collide. In teaching toward conceptual change, it is counterproductive to simply cover more materials and present an extensive list of new ideas without engaging students in their own meta-cognitive analysis. As advocated by many science education reform documents. Inquiry based science teaching may be seen as one strategy for teaching toward conceptual change, in that inquiry engages students in the exact same questioning of one's preconceptions and challenging of one's own knowledge that is characteristic of both conceptual change and scientific habits of mind (Kimberly and Allen, 2005). Some of the inquiry based instruction strategies are guided discovery and self learning strategies.

Guided discovery is one of those teaching methods that employ exploration, manipulation and experimentation to find out new ideas; it is a problem solving oriented method Akuma, (2008). Guided discovery instructional strategy, is characterized by convergent thinking. The instructor devises a series of statements or questions that guide the learner, step by logical step, making a series of discoveries that leads to a single predetermined goal. In other words, the teacher initiates a stimulus and the learner reacts by engaging inactive inquiry thereby discovering the appropriate response. Extensive review of the literature by DeJong and Jooling showed that generally speaking guided simulation discovery leads to better results than non-guided ones. It aided better understand of concepts and of course better train for the discovery process itself. (DeJong & Joolingen, (2003). According to Okoye, (2004) and Nwagbo (2004), during the early 70's the rational for science teaching shifted as discovery strategy was adopted worldwide. This was because students tended to memorize facts and concepts, most of which they did not understand. This resulted in a lack of retention and application of concepts. They maintained that there was a great burst of interest as the guided discovery strategy was adopted in the Nigeria curriculum. The guided discovery strategy is activity oriented and involves practical demonstration, discussion and experimentation. During such instruction the students employ the processes of science like observation, classification, investigation and critical interpretation of findings. In Biology, it is possible for guided discovery strategy of teaching to be enhancing students' performance. This is because of the activity oriented nature of the guided discovery strategy (Okoye, Momoh, Aigbomain, and Okecha, 2008).

Self-learning is an instructional strategy which involves using instructional materials by students. It has the following characteristics: provision for response; feedback and testing, so that students can learn either without teacher's intervention or with a minimum of teacher guidance Akinmoyewa, (2003). Research has demonstrated that, the attitudes toward science change with exposure to science, but that the direction of change may be related to the quality of the exposure, the learning environment, and teaching methods (Newble, 1998; Cracker 2006). Aiyelaagbe (2003) reported a more positive attitude of students after exposing them to self learning strategies. Similar results were obtained in the study conducted by Mattern and Schau (2004) after exposing students to a self learning device.

Abimbola, (2013) agreed that Teacher Centred methods of teaching science predominate in Nigeria secondary schools are not effective. Wood and Gentile (2003), Blair, Schwartz, Biswas & Lewlawong (2007) express their opinions that the conventional method 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.

Cognitive style of the students which is the second moderating variable of study; cognitive style defined by Mansaray and Ajiboye (1997) is the individual's mode of perception and conception of educational environment. Ahiakwo (1998) in Ige (2001) described cognitive style as a psychological disposition which shows how individual is inclined to think, learn and process information. Most of the differences encountered by students in learning could be described in terms of the different manner in which students perceive and analyse for details (analytical), others respond by making a general view of the whole materials (non analytical). It is believed that, for meaningful learning to take place most especially is science education consideration should be given to the cognitive style of individual learner and the relevant instructional strategies (Olagunju and Ogundiwin, 2008).

The actual state of gender inequality and probable ways of restoring gender balance in various fields of human endeavours has been the concern of many research studies. Gender which is one of the moderating variables of the study, several researches had been carried out on the variables. 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 school as shown by their mean score (52.2 for boys and 49.8 for girls). In the same light, Ebere (2006) reported in his study of breaking gender barrier on achievement in STME, using hands-on,minds-on-science, that students (boys and girls) who were exposed to science process based learning activity oriented learning,

utilizing students manipulation of materials, yielded a more effective learning irrespective of gender than other students.

Statement of the Problem

The research is to determine the effect of guided discovery and self-learning strategies on students' achievement in Biology. The moderating effects of gender and cognitive styles will also be investigated. Thus far, effect of guided discovery and self-learning strategies on senior secondary schools students' achievement in Biology.

Hypotheses

The following null hypotheses will be tested at 0.05 level of significance

$H0_1$: There is no significant main effect of treatment on students 'achievement in Biology

$H0_2$: There is no significant main effect of gender on students' achievement in Biology

$H0_3$: There is no significant main effect of cognitive style on students 'achievement in Biology

Methodology

This study adopts pre-test, post test, control group, quasi-experimental design. It examined possible effect of Guided discovery and Self-learning instructional strategies, gender and cognitive style on students' achievement, attitude to Biology.

The sample will consist of SS II students from Six Senior Secondary Schools which are co-educational in Ibadan South West and Ibadan North West Local Government Areas, of Oyo State. The sample is drawn from six intact classes randomly selected from six secondary schools in the two Local Government Areas

The choice of SS II Biology students is made because they must have been exposed to prerequisite concepts in junior secondary school Integrated Science and Senior Secondary One Biology. They are likely to be more receptive to the teaching strategies as they are not under the pressure of preparing for external examination. The teaching of the concepts digestive system and tissues and supporting system are also appropriate to the scheme of work of Biology at this stage of their spiral curriculum.

The selections of schools will be based on the following criteria:

- Evidence of presenting students for SSCE Biology examination for at least ten (10) years.

- Co-education schools; availability of experienced Biology teachers with at least three years teaching experience; evidence of SS II students of the schools having been exposed to basic pre-requisite concepts necessary for the understanding of the concepts of the study; accessibility of the school.

Simple randomly sampling techniques were employed in drawing the participating schools as well as assigning the schools to experimental and control groups.

Research Instruments

The following six instruments will be used in this study:

i. Students' Biology Achievement Test (SBAT)
ii. Teacher's Instructional guide on Guided-discovery instructional strategy (TIGDIS)
iii. Teacher's Instructional guide on Self-Learning Instructional Strategy (TIGSLIS)
iv. Teacher's Instructional guide on Conventional Instructional Strategy (TIGCIS) used as control.
v. Cognitive-Style test (CST)
vi. Evaluation sheet for assessing teachers' performance on the use of the strategies (ESAT)

Students' Biology Achievement Test (SBAT)

This instrument was designed to measure the students' level of achievement in Biology. The instrument is made up of two sections.

Section A: This consist of the personal data of the subjects containing their gender name, school etc

Section B: This consist of 20 multiple test items of Digestive system and Tissue and Supporting System. Students will be required to pick the option in line with their views on each item. All questions are in objective form with alternative A to D. Students are to pick the correct answer out of the alternatives provided. The table of specification for the development of the test is shown in the table 4.

Table 2: Table of Specification on (SBAT)

Topic	Knowledge	Comp	Application	Analysis	Synthesis	Evaluation	Total
Digestion	5, 9	15	18		16	3	6
Dentition and dental formula	6,7,1	19	10				5
Tissue and supporting system in animal	13	8	17			20	4
Supporting tissues in plants	11, 14, 2			4, 12			5
Total	**9**	**3**	**3**	**2**	**1**	**2**	**20**

There are more items on knowledge than others because students respond better to questions involving recall than other levels of Bloom *et al*. items at the secondary

school level. The finding of Ige (2001) revealed that achievement at lower cognitive level was higher than at higher cognitive level in science. This clearly indicates that achievement decreased with increase in taxonomic level of educational objectives. This means that students perform better in questions involving recall than application.

Validation and Reliability of SBAT

This instrument was subjected to face and content validity by giving copies to experts in education, educational evaluation and science education with bias in Biology education. These experts were asked to determine its suitability for the target population in terms of clarity, breath and language. Out of the 40 items, only twenty survived scrutiny. The difficulty index is 0.42 and reliability coefficient of 0.76 was obtained using Kuder Richardson (KR.20).

Teachers' Instructional Guides (TIG)

These are teaching guides prepared by the researcher for the teachers on Guided Discovery, Self –Learning and conventional strategies. These are used during the training period for the experimental and control groups. The instruments consist of step by step mode of teaching as shown in the appendices.

Instructional strategy guides are:

- Teacher's Instructional Guide on Guided Discovery learning strategy in Biology
- Teacher's Instructional Guide on Self-learning learning strategy in Biology
- Teacher's Instructional Guide on conventional strategy in Biology.

Teacher's Instructional Guide on Guided Discovery Learning Strategy in Biology (TIGDLS)

This is a strategy that assumed a higher gradient of student's knowledge on the topic relative to that of the teacher. Students are exposed to the topics lesson on Digestive and tissue and supporting system.

Steps involved in Guided-Discovery Instructional Strategy in Biology

Step 1: Grouping of learners
Step 2: Asking questions
Step 3: Students think and interact with the instructional materials to discover and formulate response to the questions
Step 4: student share their ideas with their group members
Step 5: student discuss their ideas with whole class
Step 6: Conclusion
Step 7: Evaluation

Teacher's Instructional Guide on Self-Learning Strategy in Biology (TIGSLS)
This is a strategy that assumed a higher gradient of student's knowledge on the topic relative to that of the teacher. Students are exposed to the topics lesson on Digestive and tissue and supporting system.

Steps involved in Self-Learning Instructional strategy in Biology
Step 1: Presentation of the topic and the instructional materials
Step 2: Introduction/note to the learners
Step 3: Undertaking of the task and interaction with the instructional materials by the learners.
Step 4: Evaluation
Step 5: Monitoring of the Learning by the learners

Teacher's Instructional Guide on Conventional Strategy in Biology (TIGCS)
This is a strategy that assumed a higher gradient of teacher's knowledge on the topic relative to that of the students. Sometimes teacher talks and a lot of students talk especially on a lesson on Digestive and tissue and supporting system.

Steps involved in Conventional Strategy in Biology
- Introduction of the lesson by the teacher
- Presentation of the lesson by the teacher
- Evaluation of the learners by the teacher
- Conclusion of the lesson by the teacher

Cognitive Style Test (CST)
This instrument is in line with that of Sigel's cognitive style Test (1967). The revised edition by Awolola 2009 was adapted in this study. The CST consists of twenty cards numbered 1 to 20. Each card contains three pictures in black and white, two of which could have one thing or the other in common or could go together in some ways. The CST was used to classify the students into 'analytic' and 'non-analytic' styles on the basis of their statements regarding the way they perceive the pictures. The students were asked to respond to each set of three pictures by noting how any two of the three pictures in the set go together or are related in any way. The statements made by the students regarding the way they perceived the pictures and classified any two together could be categorized into three thus:
- Analytic Descriptive (AD);
- Categorical Inferential (CI) and;
- Relational Contextual (RC)

Analytic Descriptive Responses
Students placed together objects based on their shared or common characteristics, which are directly discernible. Example, in a card containing a Wristwatch, a man and

a ruler, participants here place together wristwatch and man because "they have leathered material on".

Categorical Inferential Responses
Participants placed together objects on the basis of super ordinate features, which are not directly discernible (abstract), but are inferred. Example, participants here placed a wristwatch and ruler together because "they are for measurement".

Relational Contextual Responses
Participants here placed together objects or events on the basis of features establishing a relational link between them. The two stimuli or objects here are independent conceptionally; rather each derives meaning from the other. Hence, this style is sometimes called global or holistic or contextual mode of categorization. Example, participants here placed together "the man and the ruler" or "the man and the wristwatch" on the ground that, "the man can measure distances with ruler or "know the time with wristwatch".

In this study, analytic style participants were those who scored above the median on Analytic Descriptive (AD) and Categorical Inferential (CI) responses and below the median on Relational Contextual (RC) responses. Non-analytic style participants were those who scored above the median on Relational Contextual (RC) responses and below the median on Analytic Descriptive (AD) and Categorical Inferential (CI) responses.

Table 3: Table of Specification for CST

S/N	Content Area	Responses	Number of Items
1.	Analytic Descriptive Responses	Placing objects of common characteristics together	7
2.	Categorical Inferential Responses	Placing objects together on the basis of super ordinate features which are not directly discernable but are inferred	6
3.	Relational Contextual Responses	Placing objects/events together on the basis of features establishing a relational link between them.	7
	Total		**20**

Source: Sigel (1967), Afuwape (2002) and Awolola (2009)

Validation of Cognitive Style Test (CST)
The face validity of CST was done by showing the booklet of 20 cards which contain pictures of items to experts in educational psychology, educational technology and other technically untrained observers to determine their suitability. Pearson product moment coefficient for different responses showed stability coefficient obtained. Onyejiaku (1980) had estimated the reliability estimates of items in the CST to range from 0.62 to 0.76. Onafowokan (1998) as cited in Afuwape (2002) also trial tested the

CST using 137 JS III students in four secondary schools in Lagos, Awolola (2009) also trial tested it, The trial test results showed no ambiguities in the instrument with test retest reliability value of 0.84 was obtained.

Evaluation Sheet for Assessing Teachers' Performance on the Use of the Strategies (ESAT)

This is the guidelines for evaluating performance of the trained teachers on the effective use of these strategies

- Guided discovery Strategy
- Self-Learning Strategy
- Conventional Strategy

This is a rating scale that is made up of two sections namely;

Section A: This consisted of the personal data of the trained teacher containing name, school, period, class taught, date and the summary of the concept discussed in the class.

Section B: This consisted of items to be evaluated. The items were placed on a 5-point likert type rating scale ranging from Very Good (VG), Good (G) Average (AV) Poor (P) and Very Poor (VP).

Validation of ESAT

The instrument will be trial tested to ensure its reliability. For the purpose of validation, expert's attention was drawn to ascertain the appropriateness of the concepts and methods to the target population. The observations and comments of these experts were taken into consideration while preparing the final draft.

Research Procedure

The following time schedule were adopted

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

Training of Research Assistants

Training was done step by step through the explanation on the teaching guides (guided discovery and Self-Learning). After one weeks training, the research

assistants was asked to teach for one week of demonstration lessons, (i.e. one weeks of training and one week of scrutiny). Assessment guides prepared by the researcher was used to select the research assistants found capable. Research assistants on experimental group one were trained on the use of guided discovery strategy. Research assistants on experimental group two were trained on Self-Learning strategy. While research assistants on control group were only exposed to conventional lecture method.

Administration of Pre-Test

All the thirty students (SSII) in each representative school of the six schools were used for the experiment and were given a pre-test on all the evaluative instruments. The pre-test lasted for one week. The SBAT and CST were administered in that order.

Treatment Procedure

The treatment will be carried out on the experimental and control groups. During this period, students will be taught on digestive system and tissues and supporting system aspects of the Biology concepts by the research assistants using.

1. **Guided Discovery Instructional strategy in Biology,** by using the following steps;
   Step 1: Grouping of learners
   Step 2: Presentation of the topic and the instructional materials by the teacher
   Step 3: Setting up of the task to be accomplished by the learners
   Step 4: Undertaking of the task by the learners through the supervision of the teacher
   Step 5: Feedback from the learners
   Step 6: Conclusion
   Step 7: Evaluation of the Learners

2. **Self-Learning Instructional strategy in Biology,** using the following steps:
   Step 1: Presentation of the topic and the instructional materials
   Step 2: Introduction/note to the learners
   Step 3: Undertaking of the task and interaction with the instructional materials by the learners
   Step 4: Evaluation
   Step 5: Monitoring of the Learning by the learners

3. Finally the **Conventional strategy** in which the research assistants on control groups use only the conventional lecture method.
   - Introduction of the lesson by the teacher
   - Presentation of the lesson by the teacher
   - Evaluation of the learners by the teacher
   - Conclusion of the lesson by the teacher

This stage lasted for eight weeks. At the end of the treatments, one week was used for the administration of the evaluative instruments i.e. the post-test.

Post Test

Students Biology Achievement Test (SBAT) was administered as post tests on the subjects at the end of the treatment session.

Method of Data Analysis

Analysis of data collected in relation to this study was done by using Descriptive Statistics (mean, standard deviation) to explain the mean distribution of the various groups (Treatment, Gender and Cognitive styles) and inferential statistics (ANCOVA) was used to determine the differences between the mean of post test scores with the pre test scores as the covariates. Scheffe post hoc test was used where significant main effects are obtained.

Results

$H0_{1:}$ There is no significant main effect of treatment on students: (i) Achievement in Biology

Table 4: Summary of Analysis of Covariance (ANCOVA) Table Showing Treatment, Cognitive Style and Gender Associated with Students' Achievement in Biology

Source	Type III Sum of Square	Df	Mean Square	F	Sig.	Eta Squared
Corrected Model	2238.064	12	186.897	47.897	.000	.717
PREACH	1.185	1	1.185	.304	.582	.001
Main effect						
Treatment Group	1540.465	2	770.232	197.804	.000	.635
Cognitive style	16.824	1	16.824	4.321	.039	.019
Gender	13.490	1	13.490	3.464	.064	.015
2-way interaction						
Treatment & Cognitive style	2.824	2	1.412	.363	.696	.003
Treatment & Gender	9.794	2	4.897	1.258	.286	.011
Cognitive Style & Gender	2.109	1	2.109	.542	.462	.002
3-way interaction						
Treatment & Gender & Cognitive style	8.160	2	4.080	1.048	.352	.009
Error	883.920	227	3.894			
Total	**3121.983**	**239**				

Table 4 presents the summary effects of treatment, gender and cognitive style on students' achievement in biology. The result shows that the main effect of the treatment group was significant. F (2,227) = 197.804, P > 0.05 therefore the null hypothesis was rejected.

To find out the magnitude of the mean scores of the group's performance, Table 5 is presented

Table 5: Estimated Marginal Means of Posttest Achievement Scores by Treatment and Control Group

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Guided Discovery	14.21	.242	13.820	14.600
Self Learning	14.56	.224	13.174	14.954
Conventional	12.53	..200	12.833	12.221

Table 5 revealed that students in the Self Learning treatment group had the highest adjusted post test mean achievement scores ($\bar{x}$ = 14.56) followed by the Guided Discovery treatment group ($\bar{x}$ = 14.21) while students in the Modified Conventional strategy group had the least adjusted mean achievement scores ($\bar{x}$ = 12.53). Further, the source of the significant difference obtained in table 4.3 was traced using Scheffe post-hoc test.

Table 6: Scheffe Post-Hoc Tests Analysis of Post-test Achievement Score According to Treatment Group

Treatment	N	Mean	1. Guided Discovery	2. Self Learning	3. Conventional
1. Guided Discovery	81	14.21			*
2. Self Learning	83	14.56	*		*
3. Conventional	76	12.53			

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

The result from post-hoc analysis in Table 6 revealed that group Self Learning was significantly different from Guided Discovery and Conventional strategy strategies in their achievement scores. Guided Discovery was significantly different from Conventional strategy in achievement scores, these revealed that the direction of increasing effect of instructional strategy (treatment) on environmental achievement was Conventional strategy < Guided Discovery < Self Learning.

$H0_2$: There is no significant main effect of gender on students' achievement in Biology.

From tables 4 the result shows that there was a significant main effect of gender on students' achievement in biology as F (1,227) = 3.464, P> 0.05, η^2 = .015.Hypothesis 2 was not rejected.

$H0_3$: There is no significant main effect of cognitive style on students' achievement in Biology.

From tables 4 the result show that there was a significant main effect of cognitive style on students' achievement in biology as F (1,227) = 4.321, P < 0.05. η2 = .019. The effect size of 1.9% was negligible. Therefore, Hypothesis 3a was rejected.

Table 7: Estimated Marginal Means of Posttest Achievement Scores by Cognitive Style

Cognitive Style	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Analytical	14.31	.159	13.539	15.102
Non analytical	12.78	.204	12.103	13.315

Analytical students had higher Mean = 14.31 while the Non analytical students had a lower Mean = 12.78, the difference was significant.

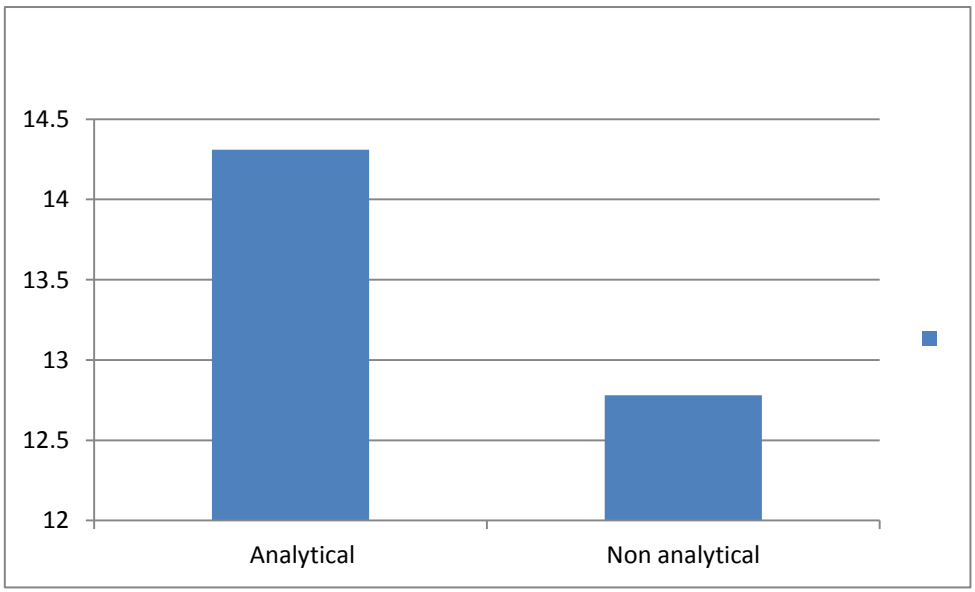

Figure 2: Bar Chart Showing Estimated Marginal Means of Posttest Achievement Scores by Cognitive Style

Figure 2 shows Estimated Marginal Means of Posttest Achievement Scores by Cognitive style. The magnitude of the significant main effect indicates Analytical students had higher Mean = 14.31 while the Non analytical students had a lower Mean = 12.78**.**

Discussion, Education Implication and Recommendations

The results indicated that there is a significant main effect of treatment on students' achievement in biology in guided discovery strategy experimental group and self learning strategy but no significant effect in conventional strategy which serves as control group. These indicate that guided discovery strategy and self learning strategies is capable of improving students' achievement in Biology. The finding is in consonance with the results of researchers in guided discovery strategy: Onanuga (2004) concluded that the use of discovery method caused the students who are

exposed to it to perform better than students exposed to conventional method of teaching. His finding was also in agreement with Ugwanyi (2008), who noted that the guided discovery method of instruction is more effective than the commonly used expository methods in Biology. The students are more likely to remember concepts they discover on their own. Mayer, (2004) asserted that teachers have found that discovery learning is most successful when students have prerequisites knowledge and undergo some structured experiences.

The result of this study showed that there was a significant main effect of cognitive style on students' achievement in biology in guided discovery, self learning and conventional strategies respectively. The indication of this result is that students' cognitive style influence students' achievement in biology. The result negate the finding of Carolina *et al.* (2012) in their study of influence of the cognitive style called Field dependence and field independence on academic achievement of Brazilian university student; they found that cognitive style and learning strategy significantly contributed to academic achievement. It supports the findings of Olagunju & Ogundiwin, 2008.

The findings from this study have tremendous and meaningful implication for teachers of biology, school administrators, counsellors and education policy makers. Guided discovery and self-learning strategies have statistically significant main effect on students' academic achievement in biology. These findings have created an opportunity for improving the teaching and learning of biology through the use of guided discovery and self-learning strategies to impart knowledge to the learners'. Teachers of biology should come to terms with introducing student-centre learning rather than teacher- centre learning in the learning of biology concepts. From this research study, it can be inferred that guided discovery and self-learning strategies fosters the development of practical skills which is intended to stimulate healthy intellectual climate for people to interact effectively among themselves with minimal friction. The teachers' role in both strategies is not to transmit information but to serve as facilitators for learning which includes creation and managing meaningful and impactful learning experiences, thereby, stimulating students' thinking through and appreciating a better way of solving real world challenges. The teaching of biology is far becoming more of a theoretically oriented learning rather than allowing students to learn effectively through acquiring necessary skills from guided discovery and self-learning strategies as these equip them to have a balance between structure and flexibility, learner autonomy and tutor control in a learner support strategies that is based on individual learning capabilities which will in effect facilitate self discovery. It is, therefore, imperative for teachers of biology to assume the stage of using teaching and learning strategies that will facilitate effective and stimulating teaching-learning environment.

On the basis of the findings of this study, the following recommendations are made:

1. The use of guided discovery and self-learning should be encouraged in schools for effective teaching and learning of biology. Teachers of biology should be ready to incorporate these teaching strategies.

2. Facilities and suitable learning environment should be provided, to allow effective teaching and learning in a learner-centred situations.

3. Teachers should provide the structure and opportunities for learners to do guided discovery and self-learning so as to improve leaning achievement.

This research has the potential of increasing the understanding of the way Nigerian schools can move towards improving learning capabilities and effectiveness by providing quality learning environment and opportunities to learners at all levels.

Conclusion

From the findings of the study, it was observed that treatment gender and cognitive style are significant singly on students' achievement in biology. Therefore, when teachers uses guided discovery strategy and students apply their cognitive styles these will directly enhance good achievement in biology.

The results and findings of this research should move further rather than being additional data to the understanding of the theories in teaching and learning, it should rather be a way at ensuring better response to life changes in the real world, outside the classroom environment. If guided discovery strategy is employed in schools, and students are guided on their cognitive styles in biology class, there is the tendency for the teaching and learning of this subject (biology) in secondary schools to inculcate into learners the lifelong learning skills embedded in the teaching and learning strategies employed in this study.

References

Abimbola, I.O. (2013). The Misunderstood Word in Science towards a Technology of Perfect Understanding of All. In 123rd Inaugural Lecture of University of Ilorin (p.22-31) Unilorin Press.

Adegboye, A.O. & Adegboe, O.A. (2003). An Investigation into Secondary School Students Performance in SSCE Mathematics Lafiagi. *Journal of Science Education 5, 192:25-31*.

Adeniyi, A.G. (2005). Science and Technology Education in Secondary Schools: Need for Manpower Development. *Journal of the Science Teachers Association of Nigeria*, Vol. 40, No. 1 & 2: 63-67.

Adepitan, J.O. (2003). Pattern of Enrolment on Physics and Students Evaluation of the Contributory Factors on Nigeria Colleges of Education; *African Journal of Education Research* (2) pp. 136-146.

Adesoji, F.A. (1986). The Uses of Self-Learning Device in Improving Chemistry Teaching. 27th Annual Conference Proceedings.

Adesoji, F.A. (2004). Science and Curriculum Development: An Unpublished M.Ed. Lecture.

Adeyegbe, S.O. (2000), Packaging Science, Technology and Mathematics Education to Maximize Standard, Progression and Continuity: Challenging of the Twenty-First Century. Keynote Address at 4th Annual Conference of Science Teachers Association of Nigeria (STAN), Lagos State Branches.

Afuwape, M.O. (2004). The Effect of Computer-Assisted Instruction on Students' Attitude Towards Integrated Science. *Nigeria Journal of Computer Literacy (NJCL) 5*.

Aiyelagbe, G.O (2003). The Effectiveness of Audio, Visual and Audio - Visual Self Learning Packages in Adult Learning Outcomes in Basic Literacy Skills in Ibadan. Unpublished Ph.D Thesis, University of Ibadan.

Ajewole, G.A. (2007). Effects of Discovery and Expository Instructional Methods on the Achievement of Students in O Level Biology. Unpublished Ph.D Thesis, University of Ibadan, Ibadan.

Ajewole, G.A. (2007). Teaching Terrestrial Habitat in Biology to students in African Secondary Schools for Sustainable Development. *Proceedings of 43rd Annual Conference of Science Teachers Association Nigeria,* Nzewi, Uchenna Ed. Ibadan, HEBN 287-290.

Ajiboye, J.O. (1997). A Self-Learning Programme, The Modified Lecture Method and Students Cognitive and Effective Outcomes in Some Population Education Concepts. Unpublished Ph.D Thesis, University of Ibadan, Ibadan.

Ajileye, O.O. (2006). Towards Effective Science Education: Issues in Universal Basic Education Programme. *Journal of Sports Management and Educational Research. 1, 2: 337.*

Akanbi, A.O. (2003). Trend in Physics Educational in Secondary School in Kwara State. Lafiagi. *Journal of Science Education, 5, 1&2: 69-75.*

Akinmoyewa, J.O. (2003). Effects of Co-operative, Competitive and Individualistic Use of Self-Instructional Package Learning Achievement in Biology. *Journal of Education and Society.*

Akinolu, B.M.A. (2006). Causes of Mass Failure in Senior Secondary School Chemistry in Ijebu East Local Government Area of Ogun State. *Oro Science Educational Journal. 4, 5 & 6:19*.

Akuma, N. (2008). Effects of Guided Discovery Method on Senior Secondary Students, Interest in Map Work. *African Journal of Educational Research. 12, 2: 111-116*.

Alebiosu, K.A. (2003). Effects of Co-operative Learning Models on Senior Secondary Students Learning Outcomes in Chemistry. Unpublished Ph.D Thesis, University of Ibadan.

American Association for the Advancement of Science (1989). Science for All Americans. A Project 2061 Report on Literacy Goals in Science, Mathematics, and Technology, Washington, DC.

Apata, S.F. (2007). Influence of Teachers Academic Qualification and Experience on Students Performance in Senior Secondary School Physics in Kwara State (Unpublished Master Thesis). University of Ilorin, Ilorin.

Asim, A.E. (2003). An Evaluation of the Effectiveness of Two Interactive Approaches Based on the Constructivists Perspective for Teaching Primary School Science, Unpublished Ph.D Thesis, University of Ibadan, Ibadan.

Augustine, N.R. (2005). Rising Where the Gathering Storm: Energizing and Employing America for a Brighter Economic Future. Washington D.C.: National Academy of Science, National Academy of Engineering, Institute of Medicine, National Academy Press.

Awolola, S.A. (2009). Impact of Brain- Based Instructional Strategy on Students Learning Outcome in Senior Secondary School Mathematics in Selected Local Government Areas in Oyo State, Nigeria. Unpublished Ph.D Thesis, University of Ibadan.

Biswas, G. and Leelawong K. (2007). Pedagogical Agent for Learning and Teaching: Teachable Agents. Educational Technology, 47(1), 56-61.

Campbell, P.B., Honey, E.J. and Perlman, L.K. (2004). Upping the Numbers: Using Research Based Decision on Making to Increase Diversity in the Quantitative Disciplines. G.E. Foundation Report.

Catsambis, S. (2003). The Path to Math: Gender and Racial-Ethics Differences in Mathematics Participations from Middle School to High School. Sociology of Education.

Corno, Y. (2006). Effect of Field Dependent-Independent Cognitive Styles and Cueing Strategies on Students Recall and Comprehension. Unpublished Doctoral Dissertation. Virginia Polytechnic Institute, Blacksburg, V.A.

Cracker, D.O. (2006). Attitudes Toward Science of Study Enrolled in Introductory Level Science Courses at UW-La Crosse, UW-L *Journal of Undergraduate Research IX: 1-6.*

Daniel, E, and Reid, N. (2006). Cognitive Factors That Can Potentially Affect Pupils Test Performance. *Chemistry Education Research and Practice*.

DeJong, T. & Van Joolingen, W. (2003). Scientific Discovery Learning with Computer Simulations of Conceptual Domains. *Review of Educational Research, 68, 2:179-201*.

Donald R. Cruickshank, (2003). Uses and Benefits of Reflective Teaching. The Phi Delta Kappan. Vol. 66 (10), pp. 704-706.

Fisher, D. & Frey, N. (2009). *Background Knowledge: The Missing Piece of the Comprehension Puzzle*, Portsmouth, HN: Heinemann.

Garba, R.B. (2004). Teachers Classroom Control and Students Academic Achievement (Unpublished M.Ed Dissertation). University of Ilorin, Ilorin.

Hall, J. and Saunders, O. (2003). *Adopting a Student-Centred Approach Management of Learning*, London: Kogan.

Ige, T. (2001). A Concept Mapping and Problem Solving Teaching Strategies as Determinants of Achievement in Secondary School Ecology Ibadan: *Journal of Educational Studies*.

Ikitde, G.A. (2003). *Fostering Experimental Proficiency of Students in Biology through Problem Solving Approaches*. Unpublished PhD Thesis, University of Ibadan.

Iroegbu, T.O (2003). Problem Based Learning, Numerical Ability and Gender and Line Graphic Skills at Senior Secondary Physics in Ibadan. An Unpublished Ph.D. Thesis of University of Ibadan.

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

Jebson, S.P. (2013). Relationship between Learning Resources and Students Academic Achievement in Science Subjects in Taraba State Senior Secondary Schools. *Ife Psychologia*. Retrieved on 12-03-13 from www.periodual.com

Jekayinfa, A.A, Yusuf, M.O., Yahaya, L.A, & Yusuf A. (2010). An Overview of the Philosophical, Historical, Political and Socio-Economic Factors That Have Impacted on the Development of Universities in Nigeria. In J. Okojie, I. Oloyede, & P.A.I. Obanya (Eds), 50 Years of University Education in Education in Nigeria:

Evolution, Achievement and Future Directions (pp. 47-64), Ilorin & Abuja: University of Ilorin & National Universities Commission.

Kimberly, T. & Allen, D. (2005). Approaches to Biology Teaching and Learning: Understanding the Wrong Answer – Teaching Towards Conceptual Change. *Cell Biol. Edu. 4, 2: 112-117*.

Lea, S.J. Stephenson, D. and Tray, J. (2003). Higher Education Students Attitudes to Student Centred Learning: Beyond Educational Bulimia. Studies in Higher Education, 321-334.s.

Marzona, R.J, (2004). *Building Background Knowledge for Academic Achievement*, Research on What Works in Schools. J. A. Alexandra: ASCD

Mattern, N. & Schau, C. (2004). Gender Differences in Attitude – Achievement Relationships Overtime Among White Middle-School Students. *Journal of Research in Science Teaching. 39, 4:324-340*

Mayer, R.E. (2004). Should There Be A Three Strike Rule Against Pure Discovery Learning? The Case for Guided Methods of 2.

Ndioho, O.F. (2007). Effect of Constructivist Based Instructional Model on Senior Secondary Students Achievement in Biology. In U. Nzewi (Ed), STAN 50th Annual Conference Proceedings (pp98-101) Sokoto; Heinemann Educational Books.

Nitza, B. and Yehudit, J.D., (1999). High-School Chemistry Students Performance and Gender Differences in a Computerised Molecular Modelling Learning Environment. *Journal of Science Education and Technology*.

Nnamid, S.O., Momoh, S.O. Aigbomian, D.A. & Okecha, R.E. (2008). Teachers Quality Instruction and Strategies and Students Performance in Senior Secondary Sciences. A Study of Secondary Schools in Ethiope East and Ukwuani Local Government Area of Delta State. *Journal of Institution/Psychology, 2, 1:"13-17*.

Nwagbo, C. (2004). The Relative Efficiency of Guided Inquiry and Expository Methods on Achievement in Biology Students of Different Levels of Scientific Literacy. *Journal of STAN. 36, 1& 2: 43-51*.

Nwagbo, C. (2005). The Relatives Efficacy of Guided Discovery Inquiry and Expository Methods of Difference Levels of Scientific Literacy. *Journal of Science Teachers Association of Nigeria* (JSTAN).

Obioma, G. (2008). Resources for Science, Mathematics and Technology (STM) Education in the Context of Education Reforms in Nigeria *Proceedings of 47th Annual Conference of STAN,* Nzewi, U. Ed. 3 – 7.

Ojo, O.J. (2004). Relative Effectiveness of Self-Regulating and Co-operative Learning Strategy on Learning Outcomes in Senior Secondary School Mathematics. Unpublished Ph.D Post Field, University of Ibadan, Ibadan.

Okafor, P.N, (2003). Effects of Co-operative Learning and Conceptual Pedagogical Strategies on Students Achievement and Attitude Towards Chemistry. Unpublished Ph.D Thesis, University of Ibadan, Ibadan. Okene Local Government in Secondary School Biology in Okene Local Government.

Okooboh, M.A. Afolabi, M.A. & Asilika, D.A. (2004). Science and Technical Education in a Democratic Government for Sustainable National Development. The Conference: *Journal of Contemporary Educational Thoughts*. 1, 1:44-45.

Okoye, N.S. (2004). Factors Affecting Teaching and Learning. The Teacher, Subject Matter and Environment Dimension in Ughamadu, K.A. and Okoye, N.S. (Eds) Principles, Methods and Strategies for Effective Teaching, Agbor KMENSUO Educational Publishers.

Okoye, N.S. Momoh, S.O., Aigbomian, D.O. and Okecha, R.E. (2008). Teachers Quality, Instructional Strategies and Students Performance in Secondary School Science. *Journal of Instructional Psychology*.

Olagunju, A.M. and Ogundiwin, O.A. (2008). The Impact of Three Modes of Instruction and Cognitive Style on Students Environmental Attitude towards Pollution in Biology, *Ibadan: African Journal of Educational Research*.

Olagunju, W.F. (1995). The Effect of Concept Mapping Strategy, Cognitive Style and Gender on Learning Outcome in Biology. Unpublished Ph.D Thesis, University of Ibadan, Ibadan.

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

Oliveria, J.D. Olivera, V. & Souza, C. (2009). Estilos Cognitivos: Uma Pegnisacomestudantez de contabilidade. Brazilian Business Review.

Onanugu, P.A. (2004). Differential Effects of Guided Discovery and Conventional Methods of Secondary School Students Achievement in Agricultural Science, *African Journal of Educational Research*. 7, 1 & 2.

Onyejiaku, F.O. (1980). Effects of Cognitive Styles and Instructional Strategies on Academic Performance, An Unpublished Ph.D. Thesis, University of Ibadan, Ibadan, Nigeria.

Opeola, S. M. (2003). Effectiveness of Branching Programme Instruction as a Method of Teaching Biological Concepts. Unpublished Ph.D Thesis, University of Ife, Ile-Ife.

Orukotan, A.F. (2003). The Relative Effects of Instructional Strategies of Framing and Rehearsed on Senior Secondary School Students Outcome in Biology Topics. Unpublished Ph.D Thesis, University of Ibadan, Ibadan.

Osa, C.T. (2003). The Relative Effects of Instructional Strategies of Framing and Rehearsed on Senior Secondary School Students Outcome in Sociology Topics. Unpublished Ph.D Thesis, University of Ibadan, Ibadan.

Paris, S.G., Lambor, K.M. and Packard, B.W. (2003). Hands-on Biology: A Museum-School University Partnership for Enhancing Students Interest and Learning in Science. The *Elementary School Journal*.

Roschelle, J. (2003). *Learning Interactive Environments: Prior Knowledge and New Experience*, DartmoNth: University of Massachusetts.

Seung, Y.L., Bradford, W.M., James C.L., (2011). *Modelling Narrative-Centered Tutorial Decision Making in Guided Discovery Learning*, AIED Proceedings of the 15th International Conference on Artificial Intelligence in Education. Pages 163-170.

Solomon, R.O. (2004). Gender Differences and Students Achievement in Secondary School Biology in Tinajero, C. & Paramo, M.F. 1998. Field –Dependent – Independence Academic Achievement: A Review of Research and Theory. *European Journal of Psychology of Education*.

Summary Report. Gender Differences in Student Achievement. The Research Bulletin No 10, October 1999: Gender Differences in Student Achievement and In Rates of Participation in the School Sector, 1986 – 1997.

Tinajero, C. & Paramo, M.F. (1997). Field-Dependence-Independence and Academic Achievement: A Re-examination of Their Relationship. *British Journal of Educational Psychology*.

Ugwanyi, J.A. (2008). Effect of Guided Discovery Achievement in Physics in Selected Secondary Schools in Nsukka, Enugu State, Nigeria. *Nigeria Journal of Technical Education*. 15.

Zhang, L. & Sternberg, R.J. (2005). A Threefold Model of Intellectual Styles. *Educational Psychology Review*.