EFFECTS OF INTERACTIVE-INVENTION AND PROBLEM-BASED INSTRUCTION STRATEGIES ON STUDENTS' ATTITUDES TO BIOLOGY

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ABSTRACT

The prevailing poor outcomes of students in biology every year in Senior School Certificate Examination suggests that the instructional strategies employed by teachers may be inappropriate. There is the need to employ strategies where student will engage in problem solving skills and involve class interaction coupling with wide discussion to ascertain its effect on students' performance This study therefore, concerned itself with the effects of Interactive-invention and Problem-based Instruction strategies on achievement in Biology. It also examined the moderating effect of students' self-efficacy on learning outcome in Biology. A pre-test, post-test, control group quasi –experimental research design was adopted for this study. The participants for the study were made up of 201 (79 male and 122 female) Senior Secondary Class two (SSII) Biology Students selected from six purposively co-educational secondary schools in Ibadan North, Ibadan North East and Akinyele local government Areas of Oyo State. Seven research instruments were used for this study, Biology Achievement Test (BAT),Students Biology Self Efficacy Questionnaire (SBSQ), Teachers Instructional Guide Problem-based Learning Strategy (TIGPBLS);Interactive Invention Strategy (TIGIIS) and Conventional Lecture Method (TIGCLM) including Evaluation Sheet for Assessing Instructors' Performance during Training (ESAIP). Three hypotheses were tested at 0.05 alpha levels. Data collected were analyzed using Analysis of Covariance (ANCOVA). There was a significant main effect on treatment on the Academic Achievement of the Students in Biology ($F(2,182) = 14.355$ $P < .05, \eta^2 = 0.136$). Problem-based learning strategy was significantly different from Interactive Invention and conventional strategies in their achievement scores.. There was no significant difference between of Self-efficacy on Students' Achievement in Biology ($F(2,182) = 0.022$, $P > .05$, $\eta^2 = .000$). Problem-based learning strategy is effective in improving students' Academic Achievement of the Students in Biology taking into cognisance the self efficacy of students concerned.

Keyword: Biology. Interactive Invention, Problem-Based Learning, Self Efficacy

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Introduction

Science and technology education is the foundation for sustainable national development by protecting human societies from ignorance, literacy, diseases and poverty. .The major aim of science teaching is to promote the understanding of the concept being taught with a view of applying knowledge of such understanding to real life situations. Science is a dynamic human activity with understanding the working of the world However, science first appear in the Nigeria curriculum in 1959 when the church missionary university society established schools and other related science subject were introduced such as botany, physiology, music, medicine and agriculture as project offered in the past on campus. The purpose of education is to produce wholesome, pleasant and understanding individual who will interact wisely and purposely within and outside the environment and in line with this Biology education aims at helping the child to acquire appropriate skills, ability and competences that would enable him to contribute to the development of the society**.** The national policy on education makes it compulsory for all students to offer at least a science subject at the senior secondary school. Biology is the subject mostly preferred and chosen by many students of science. Biology is looked upon to provide (i) solution to most human activities and problems e.g. food, nutrition drug, pollution, disease, radiation, health, hygiene, family life natural resources conservation and management as well as biotechnology and ethics (UNESCO 2012). Also considering the merit and importance of Biology and its popularity among all students, one would expect student's achievement in the subject to be appreciable.

The status of biology at the senior secondary level could however be described as enigmatic, at one end of the spectrum, students see the subject as a "soft" option when compared with physics and chemistry Abubakar 2012. Many factors have however, been highlighted as contributing to students under achievement in biology – these comprises in adequate curricular content, topic difficulty overloaded time table, teacher related problems inadequate preparation on the parts of the students, teaching methods, large classes, lack of innovations in which indicated a steady decline in Candidate's Performance in biology at SSCE WAEC 2005-2010 (Umeh, 2006). The Table 1 shows the performances of students in science subjects but her focus on biology from 2002 – 2012.

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.

The above Table 1 shows the percentage performance of biology from 2002 to 2012. The percentage fail each year is more than the percentage pass (except in 2006 that the percentage fail is almost equal to the percentage pass) which indicates poor performance. The high percentage of candidates who failed WASSCE yearly is becoming alarming and worrisome. Some candidates' results were not recorded and this may be due to examination malpractice, missing scripts or students absent, that is why the sum of the percentage in the table 1. 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 has been slow in improving as stated by Jekayinfa, Yusuf, Yahaya& Yusuf, 2010) and supported by Abimbola (2013) who concluded that the percentage of candidate admitted did not reach 20 percent during this period, except1998/1999 academic session when it was 23.09 percent.

Chief Examiners report for 2005 states that students were unable to relate the functions to specific parts of the skeleton a lot of candidate gave a blanket answer instead of specifying the action of the biceps and triceps muscles as well as their bones of attachment. Many candidates could not explain how support is brought about in woody and herbaceous plants. Some of them mention stem as a means of support. West African senior school Chief Examiners Report for the year 2007 state that most candidates were unable to score average marks. Most candidates have problems in drawing the female reproductive system. They did not give title to their

diagrams, did not rule their guidelines and in many cases the guidelines did not touch their diagram. Candidates also drew the urinary system along with the reproductive system and so lost marks a number of candidates also mark due to spelling errors e.g. many candidates could not correctly spell the cervix.
The trend also continues in the year 2008-2012 reports that there was no significant improvement of candidates when compared to previous years. Also (Abimbola 2013, Ibe and Imaduabum 2004)

Research on Problem Based Learning (PBL), especially as used in medical schools, has focused primarily on comparing the outcomes of Problem Based Learning to more traditional instruction (Saleh,2011). Much of this research has focused on the effectiveness of the pedagogy to foster learning. A review of the literature on effectiveness on Problem Based Learning in face-to-face 1nstructional settings leads to mixed conclusions. Rosenshine, and Mesister, (1995.) used meta-analysis to compare 35 studies of PBL in medical education. The authors found that Problem Based Learning was superior with respect to students' clinical performance, but traditional methods did not differ substantially on tests of factual knowledge. Mitchell (1995) produced similar findings. Students of conventional curricula outperformed Problem Based Learning students on measures of basic science while PBL students scored higher on clinical examinations. A more recent study (Dana, 2007) produced similar overall results. They found a mild negative effect favouring traditional approaches for the assessment of student `knowledge, although these differences were encountered in first and second year of medical school and evened out in the fast two years. Problem Based Learning students gained slightly less knowledge but remembered more of it over time (retention). The results for skills were consistently positive favouring the Problem Based Learning curriculum.

Interactive learning describes a method of acquiring information through hands on, e interactive means. The opposite of interactive learning is passive learning, which is merely observing a learning process or just listening to information. Interactive learning model is based on theory and research indicating that social interaction is an essential component of classroom learning. They are strategies that involve students working collaboratively to reach common goals. These are to increase leaner involvements in classroom activities, develop their social interaction skills, and provide students with leadership and decision making. Eggen and Kauchak (2006) reported that the explicit approach to teaching concepts and skills provides culturally and linguistically diverse students with additional structure, which facilities learning. Okurumeh (2008) used interaction invention strategy with other retention enhancing strategies to teach the concepts of sets, statistics and probability to 346 SSII students from Delta State, Nigeria, and reported that the treatment had a significant effect on students achievement in mathematics with the result the analysis showed that

students in the interactive invention strategy group obtained that highest post-test mean score than interaction discussion and control

Gbolagade (2009) also conducted a study where used constructivists model based strategies of which interactive approach was among to train 36 pre-service teachers on some concepts on mathematics From the result he concluded that interactive approach enhances students achievements in mathematics more that the traditional instructional strategy. This results show that teaching with certain interactive strategies not only yield significantly increased understanding for both males and females, but also reduces the gender gap. In the most interactive taught course, the pre-instruction gender gap was gone by the end of the semester. Self- efficacy is commonly defined as the belief in ones capabilities to achieve a goal or an outcome. Bandura (1994) self -efficacy is one's self judgment of personal capabilities to initiate and successfully perform specific task at designed levels, expands greater effort, and perseveres in the face of adversity Bandura (1994). Wagner (2005) defines self-efficacy as the person's belief in his or her ability to succeed in particular situations. Wikipedia (2008) also define self-efficacy as the belief that one is capable of performing a certain manner to attain certain goals. It is belief that one has the capabilities to execute the course of actions required to manage prospective situations.

Perceived self-efficacy is defined as people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives (Bandura 1994). He further explained that self-efficacy beliefs determine how people feel, think, motivate themselves and behave. Those beliefs produce these diverse affects through four major processes that include cognitive, motivation affective and selection processes. He outlines that a strong sense of self efficacy enhance accomplishments and personal wellbeing in many ways.
Students with a strong sense of efficacy are more likely to challenge themselves with difficult tasks and be intrinsically motivated. These students will put up a high degree of effort in order to meet their commitment, and attribute failure to things which are in their control rather than blaming external factors, Self –efficacious students also recover quickly from setbacks, and ultimately are likely to achieve their personal goals. They attribute failure to insufficient effort or deficient knowledge and skills, which are acquirable. Students with low self-efficacy , on the other hand, believe they cannot be successful and thus are less likely to make a concerted extended effort and may consider challenging task as threat that are to be avoided. Student with poor self -efficacy have low aspiration which may result in disappointing academic performances becoming part of self- fulfilling feedback cycle. Bandura (1994) and (Margol, 2006).

Statement of the Problem

This study is concerned with the effects of Interactive-invention and Problem-based Instruction strategies on achievement in Biology. It also examined the moderating effect of gender of the student and their self-efficacy on learning outcome in Biology.

Hypotheses

This study is sought to provide answers to the following hypotheses at $p<.05$ level of significance.

H01: There is no significant main effect of treatment on students' achievement in Biology

H02: There is no significant main effect of self efficacy on students' achievement in Biology

H03: There is no significant main effect of gender on students' achievement in Biology

Methodology

A pre-test, post-test, control group quasi –experimental research design will be adopted for this study. 3x2x3 factorial matrix was used for the matching of variables.

Selection of participant

The participants for the study were made up of 201 (79 male and 122 female) Senior Secondary Class two (SSII) Biology Students. The subjects were from six intact classes used for the study. Random sampling technique was used to select the six purposively selected co-educational secondary schools in Ibadan North, Ibadan North East and Akinyele local government Areas of Oyo State.

The selection of the school was base on these criteria;

- Evidence of the school having good and standard biology laboratory
- Presence of qualified biology teachers
- Evidence of having well equipped library
- Readiness of the required members of the teaching staff of the schools and students to participate in the study.
- Co-educational schools

The six schools will be assigned to each treatment.

Research Instrument

The following seven research instruments were used for in this study:

1. Biology Achievement Test (BAT)
2. Students Biology Self Efficacy Questionnaire (SBSQ)
3. Teachers Instructional Guide Problem-based Learning Strategy (TIGPBLS)

4. Teachers' Instructional Guide on Interactive Invention Strategy (TIGIIS)
5. Teachers Instructional Guide on Conventional Lecture Method (TIGCLM)
6. Evaluation Sheet for Assessing Instructors' Performance during Training (ESAIP)

Biology Achievement Test (BAT)

BAT is designed to measure a students' performance in specific academic areas. The test will be used to measure academic performance of the students. The test consist of twenty multiple choice items that covered topics in the secondary school syllabus. It has two sections (A&B). Section A contains the Demographic variables (Personal data of the respondents) and section B contained test items. The options ranged from A to D. The table of specification of BAT is shown below;

Table 2: Table of Specification for BAT

Topic	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Total
Supporting tissues in Animal	5, 9	15	18	Nil	16	3	6
Supporting tissues in Plant	6,7,1	19	10	Nil	Nil	Nil	5
Reproduction in Vertebrates	13	8	17	Nil	Nil	20	4
Reproduction in plant	11, 14, 2	Nil	Nil	4, 12	Nil	Nil	5
Total	9	3	3	2	1	2	20

Validation of BAT

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 thirty survived scrutiny the average difficulty and discriminating indices were determined after the instrument was trial tested of 30 students in separate school, only 20 items survived scrutiny. The difficulty index is 0.42. And reliability coefficients of 0.80 were obtained using Kuder Richardson (KR.20), to establish the internal consistency of the items.

Biology Self Efficacy Questionnaire (SBSQ)

A general self- efficacy questionnaire was adopted from Ayodele (2011) the Students-Efficacy Scale (MJSES) and modified by the researcher to measure students self -efficacy in biology. This consists of ten (13) items to be graded based on four Likert scale ranging from strongly Agree, Agree, Strongly Disagree, and Disagree. The

positive statement will be graded 4,3,2,1, respectively while the reverse will be the case for the negative statement thus clearing out the undecided column in order to commit students to either the positive or negative side of the issues. Each statement was designed to give information about the student's perception on their own innate ability and the role of their own effort in successfully completing a task.

Validation of Students Self-Efficacy Questionnaire (SSEQ)

The first drafts of the two instruments were sent to three lectures in the Guidance and Counselling Departments in the University of Ibadan for face and content validity. The final drafts were administered to thirty students and the scores analysed for their reliability and internal consistency using Cronbachs alpha. The reliability coefficient of 0.71 was found for Self-Efficacy.

Teachers Instructional Guide on the Use of Problem –Based Learning Instructional Strategy (TIGPBLIS)

This is an instructional guide for teacher participating in the experimental group. It contains the statement of topic, objectives and the procedure expected to be followed by teachers in the teaching of the topic under consideration using problem based instructional strategy.

This prepared and was used in the training of teachers to allow uniformity in the teaching strategy. The step includes;

1. Clarify unknown terms and concepts in the problem description.
2. Define the problem: that is the list the phenomena to be explained.
3. Analyse the problem: "brainstorm": try to produce as many different explanations for the phenomenon as you can. Use prior knowledge and common sense.
4. Criticise the explanations proposed and try to produce a coherent description of the processes that according to what you think, underlie the phenomena.
5. Formulate learning issues for SDL (self-directed learning).
6. Fill in the gaps in your knowledge through self study
7. Share your findings with your group and try to integrate the knowledge acquired into a comprehensive explanation of the phenomena. Check whether you know enough now. (Schmidt and Moust, 2000: 23)

Problem based learning fosters a community of learning through collaborative and engaging group interaction. In Problem based learners depend on each other to accomplish their tasks. This means that members be responsible to each other and the group, be mutually respectful, identify as part of the group. All members of the learning community must take responsibility for their accomplishments in Problem-Based Learning

Teacher Instructional Guide on the Use of Interactive Invention Strategy (TIGIIS)

This is an instructional guide for teacher participating in the experimental group. It contains the statement of topic, objectives and the procedure expected to be followed by teachers in the teaching of the topic under consideration using problem based instructional strategy.

This prepared and was used in the training of teachers to allow uniformity in the teaching strategy. The steps include;

Phase 1: Introduction and review
Students are drawn into the lesson

Phase 2: Presentation
New content is presented and explain

Phase 3: Grounded practicing
Students practice knowledge of the concept under the teachers' guidance

Phase 4: Independent Practice
Students practice using the concept on their own

Teachers Instructional Guide on Conventional Lecture Method (TIGCLM)

This is an instructional guide for teachers participating in the classroom using the traditional method /lecture method of teaching. It contains the statement of topic, objectives, instructional materials and the procedure expected to be followed by the teachers in teaching of Reproduction and supporting tissues in plant and animals in the classroom. This was prepared and will be used in the training of teachers to allow for uniformity in the teaching strategy. The steps include;

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

Step2: Teacher presents instructional aid and discusses the contents of the lesson.

Step3: Teacher directs students to write the blackboard summary in their notebooks.

Step4: Teacher evaluates the lesson by asking students some questions in class, later on home work/assignment.

The students were taken through the four lessons of 40minutes duration each and this lasted for 8weeks.

Evaluating Sheet for Assessing Instructors Performance during Training (ESAIP)

This instrument was designed to be used in evaluating the teachers on the effective use of the instructional guides during the teaching process. It shows their presentation of concepts, mastery of the topics, use of materials and activities

directed and how effective their presentation will be for the mastery of concepts by the students.

Research Procedure

Work Schedule

This study was conducted over a period of twelve weeks as follows:
1 week for training of teachers on the use of the package and instructional guides.
1 week for scrutinization of teachers
1 week for pre-test
6 weeks for treatment (using TIGPBLIS, TIGIIS)
1week post test (BAT)

Training of Research Assistance

Training was done step by step through the explanation on the teaching guide; problem Based Instructional Strategy, Interactive Invention learning Strategy and Conventional learning Strategy.

Administration of Pretest

All the 201 students (SSII) in all six representative Schools used for the experimental and control groups were given pretest on all the evaluative instruments. The pretest lasted for one week as follows. The students Biology Achievement Test (BAT), was given first followed Students Biology Self-efficacy Questionnaire (SBSQ) in that order.

Treatment Procedure

The treatments were carried out on the entire SSII student in all the six representative Schools on the experimental and control groups. During the period students were taught on various of Biological concept (supporting tissues in plants and animals, reproduction in plants and animals) by the research assistance using the strategies.

Problem Based Learning Strategy steps include;

1. Clarify unknown terms and concepts in the problem description.
2. Define the problem: that is the list the phenomena to be explained.
3. Analyse the problem: "brainstorm": try to produce as many different explanations for the phenomenon as you can. Use prior knowledge and common sense.
4. Criticise the explanations proposed and try to produce a coherent description of the processes that according to what you think, underlie the phenomena.
5. Formulate learning issues for SDL (self-directed learning).
6. Fill in the gaps in your knowledge through self study

7. Share your findings with your group and try to integrate the knowledge acquired into a comprehensive explanation of the phenomena. Check whether you know enough now.

Problem based learning fosters a community of learning through collaborative and engaging group interaction. In Problem based learners depend on each other to accomplish their tasks. This means that members be responsible to each other and the group, be mutually respectful, identify as part of the group. All members of the learning community must take responsibility for their accomplishments in Problem-Based Learning

Interactive Invention Strategy Steps Include;

Phase 1: Introduction and review
Students are drawn into the lesson

Phase 2: Presentation
New content is presented and explain

Phase 3: Grounded practicing
Students practice knowledge of the concept under the teachers' guidance

Phase 4: Independent Practice
Students practice using the concept on their own

Conventional Strategy Steps Include;

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

Step2: Teacher presents instructional aid and discusses the contents of the lesson.

Step3: Teacher directs students to write the blackboard summary in their notebooks.

Step4: Teacher evaluates the lesson by asking students some questions in class, later on home work/assignment.

The students were taken through the four lessons of 40minutes duration each and this lasted for 6weeks.

Administration of Post test

All the SSII students in the six representative schools for the experimental and control group were given postests on all the evaluative instruments. The post test was Biology Achievement Test (BAT),

Procedure for Data Analysis

The data was analyzed using inferential statistics of Analysis of Covariance (ANCOVA) of the posttest scores, with the pretest scores as covariates multiple classification

analysis was used to determine estimated marginal means of different groups.Scheffe post hoc test was used where significant main effects were obtained. Line graphs were used to explain the significant interaction effects.

RESULT

$H0_1$: There is no significant main effect of treatment on students' achievement.
Table 4.4 represents the summary of ANCOVA results on subjects' post test achievement scores.

Table 3: 3 x 2 x 2 ANCOVA of Post-Test Achievement Scores of Students by Treatment, Gender and Self Efficacy.

Source	Sum of square	Df	Mean square	F	Sig.	Eta square
Corrected model(Explained)	420.699	18	23.372	2.549	.001	.201
Main Effect						
Pre-achievement	13.749	1	13.749	1.499	.222	.008
Treatment group	263.305	2	131.653	14.355	.000	.136
Gender	4.930	2	2.465	.269	.765	.003
Self-efficacy	.201	1	.201	.022	.883	.000
Eror(Residual)	1669.102	182	9.171			
Corrected total	2089.801	201		.		.

Table 3 shows that there was a significant main effect on treatment on the Academic Achievement of the Students ($F2,182$) = 14.355 $P < .05, \eta^2 = 0.136$). The effect size of 13.6% was fair. Therefore null hypothesis is rejected. This means that there was a significant difference in the mean achievement scores of subjects exposed to treatment on the basis of these findings, hypothesis 1a was rejected. To find out the magnitude of the mean scores of the group's performance the table 4 is presented as follows:

Table 4: Estimated Marginal Means of Posttests Achievement Scores by Treatment and Control Group.

Treatment	N	Mean	Std Error
Problem-based learning	72	13.625	2.49
Interactive Invention	64	10.609	2.75
Conventional	65	12.969	3.62

Table 4 revealed that students' in Problem-based learning strategy treatment group has the highest adjusted mean achievement scores ($\bar{x}$ = 13.625) followed by the Conventional strategy treatment group ($\bar{x}$ =12.969) while students in the Interactive Invention strategy group has the least adjusted mean achievement scores ($\bar{x}$=10.609). Further, the source of the significant difference obtained in Table 5 was traced using Scheffe post-hoc test.

Table 5: Scheffe Post-hoc Tests Analysis of Post-tests Achievement Score according to Treatment Group.

Treatment	N	Mean	Problem-based learning strategy	Interactive invention strategy	Conventional strategy
Problem-based learning strategy	72	13.625		*	*
Interactive Invention strategy	64	10.609			
Conventional strategy	65	12.969			

Pairs of groups significantly different at P <0.05

The result form post-hoc analysis in Table 5 revealed that Problem-based learning strategy) was significantly different from Interactive Invention and conventional strategies in their achievement scores.

H02: There is no significant main effect of gender on students' achievement.
Table 3 revealed that gender had no significant main effect on the academic achievement of the students' (F (1,182) = 0.269 P< 0.05. partial eta square (η^2) =0.003. the effect size of 0.2% was negligible. Therefore, hypothesis 3 was not rejected.

Table 6: Estimated marginal means of post test achievement scores by gender

Gender	N	Mean	Std error
Male	79	12.68	3.091
Female	122	12.303	3.325

Table 6 male students' had higher mean = 12.68 while the female students had a lower mean = 12.303. But the difference in their means was not significant

Ho3: There will be no significant main effect of Self-efficacy on Students' Achievement in Biology.

The results from table 3.above shows that there was no significant difference between of Self-efficacy on Students' Achievement in Biology ($F(2,182) = 0.022$, $P > .05$, $\eta^2 = .000$). Hence, the null hypothesis was not rejected.

Table 7: Estimated marginal mean of post test attitude by Self efficacy

Self efficacy	N	Mean	Std error
High	59	12.593	3.47
Medium	65	12.200	3.41
Low	77	12.558	2.91

From Table 7 High self efficacy students' had the highest mean = 12.593 while the low self efficacy students' had a lower mean = 12.200, Medium self efficacy students had the least mean = 12.200 But the difference in their means was not significant.

Discussion

The results of this study showed that the main effect of treatment was significant on achievement in Biology. The results of this study showed that the problem-based learning instructional strategy was superior to the conventional lecture method in enhancin achievement in Biology concepts over what is attainable with conventional lecture method. This finding is in agrement with the findings of Gbolagade (2009) and Adedigba (2002). Problem–based learning instructional strategy was also found to enhance the acquisition of science cognitive achievement significantly. This is in line with the report of Yilman (2005) and Miller (2004) who separately repoted that problem-based learning facilitates cognitive development. This may not be unconnected with the rigorous hands and mind on materials associated with the strategy. In this research group, students were allowed to take charge of their learning as Kinshuk (2003) reported that it has been found that students are able to learn and retain knowledge better by actively participating rather than learning passively. In the PBL classes, students work in teams to solve one or more complex and compelling 'real world' problems. They develop skills in collecting, evaluating, and synthesizing resources as they first define and then propose a solution to a multi-faceted problem. Students also summarized and presented their solutions.

Major and Palmer (2001), reported that this strategy provides students with the opportunity to gain content knowledge and skills; it helps students develop advanced cognitive abilities such as critical thinking, problem solving and communication skills and improve students' attitudes toward learning. So it is not surprising that students in this study did better than the other two study groups. The result revealed that a subject in the interactive invention strategy (IIS) does not perform better in achievement scores compared to their counterparts in conventional method. The reason may be due to the fact that there could be

misconception of ideas, if the interactive invention strategy (IIS) is not well handled, that is why Thiele and Treagust (1994) in Okebukola and Ben Akpan (2001) shows that any strategy that is inappropriately used may result in the formation of misconception in the students understanding. This result does not support the work of Gbolade, (2009) and Ukoh (2012). In which Interactive learning enables the teachers give explanation and modeling combined with students practice, invention and feedback to teach concept and procedure skills. This research is in suport of the work of Oludipe (2003) and Ukpene (2001), they noted that the conventional lecture method is administratively convenient to use in a large class and helps to cover large volume of content in short time.

Educational Implication

The exposure of the learners to Interactive-invention and Problem-based learning strategies have been found to be positively affects the enhancement of students attitude. The findings have therefore revealed the importance of using teaching strategies that are participatory and leaner cantered where learners are trained to take control and direct their learning processes for effective learning. Teachers of biology must endeavour to match teaching strategies with the manner in which students receive and process information. This study is in line with the work of researchers who believe that strategy learning by teachers improves content learning by students (Olagunju, 2002; Awolola, 2009) and to develop strategies for teaching. The study is part of the contribution of this researcher to the efforts made by educators and researchers to shift our science classroom practices from conventional (teacher-centred student-passive) to innovative, constructivism based, interest-sustaining and result-oriented strategies like problem-based instructional strategies. The problem based motivated learners to construct their own knowledge through minds-on activities and facilitates increased conceptual understanding through class-wide discussion among the students, instant feedback and clarification by the teachers. The problem-based instructional strategy not only improved performance but also increased significantly, the student's self-efficacy in Biology. It was also discovered that problem based is particularly effective in building the gap of gender on student's achievement in Biology.

Problem based learning strategy is based on constructivist theory of learning where the learner is the central focus of the learning process, particularly the work of Piaget who emphasized that knowledge is tied to action. In problem based learning instructional strategy learners are given adequate opportunity for them to take control of their learning process by participating fully in the problem solving process. When problem is presented to the groups, student brainstorm on the problem to identify issues involved, draw up learning objectives and schedule duties to group members who will embark on investigation (information search) for solution of the given problem. At the end the result is presented to the class. During the rigorous

exercises, new experiences are gained, new knowledge is acquired and their critical skills are improved. These improve the overall performance of the students. As the knowledge in science is dynamic, teachers will be equipped with how to search and verify information, search for new discoveries in the area so that they will not teach obsolete ideas and have all it takes to make the teaching of biology more interesting. The result shows that problem based low self efficacy female students performed better than their counterpart.

Myers Kelson and Distlehorst (2000) provide a rich description of the problem-based learning process: group members note the knowledge and skills that the problem demands assess their own competency with respect to these, and identify as "learning issues" that about which they need to learn more. The group plans and implements procedures for acquiring the needed knowledge and skills, each member agreeing to develop functional "expertise" in one or more of the learning issues. After a period of self- directed learning, group members return to the problem armed with their increased competency in the knowledge and skill afforded by the problem. Within a single problem, this process continues until the problem is resolved and explained, with decisions justified based on the underlying explanatory principles and mechanisms, After the resolution of each problem the group reflects on its work, both collectively and individually.

Recommendations

- Ministry of Education should put in place workshops and seminars as yearly training programmes to introduce and demonstrate the innovative teaching strategies to the science teachers.

- Teacher training institutions such as colleges of education and faculties of education in the universities should review the components of science Education Programmes in Nigeria in terms of inclusion of current science-oriented teaching strategies. When the teachers were taught using these innovative strategies, it becomes essay for them to transfer knowledge using these strategies in our science classes.

- To enhance students achievement in Biology, new activity-based instructional strategies like Interactive-invention and problem-based should be adopted in secondary schools especially in teaching Biology subjects.

- On the job training should be given to our practicing teachers on the use of these two strategies through workshops, seminars, symposia and conferences.

- Problem based instructional strategy which gives a multisensory instruction which combines the use of instruction and problem solving to create the optimal setting must be embraced by teachers and our curriculum planners as a better strategy compared to teacher centred conventional strategy.

- Teachers should develop activities that will allow active student participation in the teaching and learning of biology these are activities in which students concentrate, experience enjoyment and are provided with immediate intrinsic satisfaction that builds a foundation of interest for the future.

- Finally there is need to integrate into the school science various students' activities and materials involved in problem based learning for Biological concepts, reproduction and supporting system in plant and animal, as well as other concepts in Biology. Teachers should authentically in these meaningful and quality classroom activities which can foster or enhance learning in Biology.

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