EVALUATION OF PROBLEM-SOLVING TEACHING STRATEGY ON ATTITUDE AND PERFORMANCE OF SENIOR SECONDARY BIOLOGY STUDENTS WITH LOW ABILITY FOR SUSTAINABLE EDUCATIONAL DEVELOPMENT IN ZARIA, KADUNA STATE

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Abstract

This study investigated the impacts of Problem-solving strategy on attitude and academic performance in Biology among Senior Secondary Students of low ability in Zaria Educational Zone, Kaduna State Nigeria. The population comprises all the co-educational senior secondary schools in Zaria Zone, with total number of one thousand six hundred (1600) students. The design of the study was Quasi experimental and control with Pre-test and Post-test. Two SS schools in the area with a total number of one hundred and eighty-five (113male and 72 female) students were selected as sample of the study using simple random sampling technique using ballot method. One school formed the experimental group that received treatment via problem-solving strategy while the second school was used as the control group. High, average and low ability levels were determined using their pre-test scores. The experimental group was taught using problem-solving strategy while the control group was taught using conventional lecture method. Instruments used were developed and also used for data collection in this study i.e. Biology Performance Test (BPT) and Student Attitude Questionnaire, (SAQ). Data generated were subjected to descriptive statistical tool while Analysis of variance using Kruskal Wallis was used to test hypotheses and determines significance of the groups, at P≤0.05. The findings of the study showed that problem-solving had significant effects on the academic performance of the students of low ability. Low ability students that were taught biology using problem-solving strategy improved in their attitudes, academic performance and retained the learnt concepts better than those taught using lecture method. Neither male nor female in the two groups performed significantly better than the other in Biology after treatment. Based on the findings of the study, the researchers recommended that problem-solving strategy should be used to teach biology at secondary school to enhance attitude and performance of low ability students.

Keywords: Biology, Problem-Solving, Students, Low ability, Attitude, Performance

Introduction

Science is a systematic enterprise that builds and organize knowledge in the form of testable explanations and knowledge that can be rationally explained and reliably applied to everyday life. The field of science education includes work in science content, science process science skills, some social science and some teaching pedagogy. Bichi, (2016) stated that the purpose of education is not just making a learner literate, but adds rationale thinking, knowledge, skills, self-efficiency and self-independent. Thus, in every human society, education is meant to pass onto new generations the existing knowledge of their physical environment, to introduce them to the organization of the society and teach them skills for performing their daily

jobs with ease and as such boost the manpower development and economic growth of the country.

Ibe (2013), observed that, the education standards call for more than science as a process in which students learn such skills as observing, inferring, experimenting, etc. In this way students actively develop their understanding of science, combining scientific knowledge with reasoning and thinking skills. To achieve these goals as desired, it is highly required of teachers at all levels to have high sense of self confidence for the enhancement of teaching and learning of scientific concepts and principles that can lead to positive scientific and technological development.

Biology is one of the core science subjects taught in Nigerian secondary schools. It is the backbone of science as it is the study of life and therefore plays an essential role in harnessing interaction between living things and its environment. (Nwagbo and Chukelu, 2011; Anyanwu, Obochi and Isa 2015) observed that biology forms a binding force among various science courses like Biochemistry, Pharmacy, Veterinary Medicine etc. and also gives learners the opportunity to relate with some of the most important ecological issues affecting the environment.

The Senior Secondary School Biology curriculum is designed to serve the needs and interest of the students of different abilities. Consequently, upon the introduction of the 6-3-3-4 system of education, the curriculum recommended among others that experimentation, demonstration, problem-solving and even field trip resting on practical activities of the students should be used in the teaching of science subjects (FME, 2005 in Federal Republic of Nigeria and NPE, 2013). The expectation could be that a successful implementation of the curriculum objective is based on the recommended teaching techniques. The learner would be equipped with adequate knowledge, positive attitude and science process skills that would enhance his performance, sustain his interest and also serve as springboard for the nation's scientific, economic growth, and technological breakthrough. Contrary to these expectations, the level of performance among secondary school Biology students has not been encouraging. The objectives of Biology Education curriculum as provided in the National Policy of Education (NPE, 2013) include the following among others.

Adequate laboratory and field skills in biology; inculcate in the learners' meaningful and relevant knowledge in biology and functional scientific attitudes. Uza, (2014) stated that lecture method is the most commonly used method by science teachers. If the Nigerian child is to be of any use to their society they must be taught using methods that would encourage acquisition of skills and attitude that would encourage the economic growth of the nation.

As one of the oldest industry, education is the main instrument used by the society to preserve, update, upgrade and maintain the social heritage to an equilibrium. The economic growth of any nation depends largely on the success of education and development of manpower of such nation. Education is a backbone for economic growth and technological advancement of any nation. According to Federal Ministry of Education, (2013), the purpose of education is not just making a learner literate, but adds rationale thinking, knowledge, skill, self-efficiency and self-independent. Uza (2014) stated that one of the major goals of education in Nigeria

is the acquisition of appropriate skills, development of mental, Physical and social ability that houses human and individual endeavour to live and contributes to the development of the society. By and large, knowledge creation via science education and its application for development in Nigeria in particular is the key to the nation's economic growth, global competitiveness and meaningful job creation in a global context where there are significant shifts in knowledge production accompanied by shifts in global wealth economy.

Lecture Method is a method of teaching which involves verbal presentation where the teacher delivers the lesson to the students with little or no active participation by the students. It is also known as didactic, or teacher centered approach involving largely a one-way form of communication from the teacher to the students, the teacher does most of the talking, while the learner remains a passive listener. Lawal, (2009) maintained that when learning is augmented by method such as laboratory via practical experience, demonstrations and visual presentation, teaching becomes more appropriate and meaningful learning and positive attitude takes place.

Problem-solving strategy: If students are to successfully understand with authentic complex biological problems as scientists and citizens, they need to practice solving such problem during their secondary years. Researchers described the development of research-validated Physics curricular emphasizing process skills in problem-solving and showed that solving authentic, complex Biology problems require many of the skills that practicing physicists and biologists use in representing problems, seeking relationships, making predictions and

verifying or checking solutions, acquiring these skills can help biology students become competent problem solvers. Thus, if students are to acquire basic science skills, concepts and principles of Biology, the need for teachers to employ students' activity based approach through problem-solving strategy must be taken seriously. To ensure effective teaching of science in secondary schools, Obeka, (2016), stressed the fact that science is better taught by "doing" in order to promote and development scientific and manipulative skills, interest and attitude in the subject.

Attitude is one of the major factors that interfere with academic performance of students. Attitude however, is defined by Lawal (2009) as the predisposition to react positively or negatively towards object, ideas, institution or people. Thus, if students hold positive attitude towards a particular course or subject, it is relatively easy to lead them towards desirable objectives which will in turn enhance their performance and also improve the national economic growth.

Low ability level: in a normal class, students are found to have different levels of learning abilities. This applies to any science class for the entire population of the students have varieties of learning abilities. Their abilities are referred to as varied abilities, thus, while some students may find a learning task easy to complete, others may find it difficult to understand. The weakness of candidates in biology generally was linked to the fact that candidates lack basic concepts and not able to link biological concepts to real life situation (Lakpini, 2006, Lakpini and Atadoga 2012). According to Lakpini, (2006) and Mari (2015) varied ability can be determined in three levels (i) High achievers, (ii) middle/average achievers

and (iii) low achievers. The low achievers who usually perform poorly is the focus of this paper. These group of learners are usually found in Nigerian science classes. Getting a way to improve their attitude and performance will go a long way to also improve the economy of the country.

Gender is also another factor interacting with performance, Adebanjo, (2014) and Obochi, (2019) in their individual studies have observed that gender issues both on the part of the teacher and the students have been documented to affect academic performance and some other learning outcomes. Abdulraheem (2012) and Mari, (2015) observed that gender inequalities are interwoven with social class, ethnicity, sexuality, disability and other factors identified as influencing attainment. In addition, Adebanjo (2014), also linked gender and academic achievement with patterns of behavior. He noted that there are signs of boys being vulnerable to becoming disaffected. He stated further that boys tend to be less careful about rules and more indifferent to being reprimanded. This study is concerned with the alarming crisis in relation to students' attitude and academic performance in science subjects and especially Biology.

Statement of the Problem

The poor performance of students in the subject has been a major concern to many stakeholders in the subject. Like any other science subject, the syllabus of this activity based subject emphasis the use of activity-based method of instruction. Unfortunately, as reported by researchers such as Lakpini (2006) and Lawal, (2009) teachers shy away from activity-based teaching method and rely mostly on easy go lecture method which in most cases are often inadequate and inappropriate for meaningful learning to take place. However, in spite of these objectives and numerous efforts aimed at improving

students' performance in Biology, the subject has continued to witness low rate of academic performance. The poor performance has been attributed to the methods the teachers use in teaching the subject. It is on this note that the study investigated the effects of problem-solving teaching strategy on the attitude and academic performance in biology among Senior Secondary School students of low ability level.

The Objectives of the Study

The objectives for this study were to:
i. examine the effects of problem-solving teaching strategy on academic performance in Biology among students of low ability.
ii. determine the effects of problem-solving teaching strategy on attitude of low ability students in Biology.
iii. examine the effects of problem-solving teaching strategy on academic performance of male and female students in Biology.

Research Questions

The study investigated the following research questions:
1. What are the differences in the mean performance scores of students of low ability level taught Biology using problem-solving teaching strategies and their counterparts taught using lecture method?
2. What are the differences in the mean attitude scores of low ability level students taught Biology using problem-solving teaching strategy?
3. What are the differences in the mean academic performance scores of male and female students taught Biology using problem-solving teaching strategy?

Null Hypotheses

HO_1: There is no significant difference in the mean academic performance scores of low ability students taught Biology

using problem-solving strategies and those taught using lecture methods.

HO$_2$:   There is no significant difference in the mean attitude scores of low ability students taught Biology using problem-solving teaching strategy.

HO$_3$:   There is no significant difference in the mean academic performance scores of male and female students taught Biology using problem-solving teaching strategy.

Methodology

The research design is quasi-experimental design using pretest and post-test control group design in which two intact classes were involved and assigned to two different treatments. The experimental group (EG) received six weeks' Biology lessons using Problem- solving teaching strategy in form of activities such as hands-on-minds-on, do it yourself and learn by doing, while the control group (CG) was taught same topics using traditional lecture method, for period of six (6) weeks. Pre-test O$_1$ was used to determine the equivalence of the two groups before the experiment, while the post-test O$_2$ was used to find out whether or not the problem-solving teaching strategy had any impact on attitude and academic performance of the students.

The population for the study comprised all the SS2 Biology students in Public Secondary Schools in Zaria Educational Zone. The total number of students in the population is 1600 made up of 791 males and 809 female students. The two co-educational schools used in the study consists of 113 males and 72 female given a total number of 185 students. The sample size of 185 is in line with the Central Limit Theory of Tuckman (1975). The instrument for the study was validated by three senior lecturers from Ahmadu Bello University Zaria. The test scores for CA, were used to classify the subjects into the various levels of abilities, the two groups were then taught for six weeks each. They were each post-tested, the scripts were marked and the scores subjected to descriptive statistics to answer the research questions, Post-Hoc (Pairwise) was used to compare students' performance while analysis of variance was used to test the null hypotheses stated at *P≤0.05*.

Results
Research Question 1

What are the differences in the mean academic performance scores of students of varied ability level taught biology using problem-solving teaching strategy and their counterparts taught using lecture method?

To answer research question one, Post-test data generated through BPT were subjected to descriptive statistics to calculate mean and standard deviation, as shown in Table 1.

Table 1: Means and Standard Deviation of Post-test Scores of Varied Ability Students for EG and Control Groups

Ability Level	Treatment	Mean	Std Error	Mean Diff
Low	Problem-solving	13.62	0.32	
	Control	11.63	0.36	1.99
Middle	Problem-solving	15.50	0.25	
	Control	14.00	0.57	2.73
High	Problem-solving	19.14	0.41	
	Control	16.76	1.11	2.38

Table 1 revealed that among the low ability levels the mean difference between problem-solving and lecture were ($\bar{X}=$ 1.99, 2.73 and 2.38) respectively in favor of problem-solving strategy. The Table also showed that students of low ability performed better when taught using problem-solving approach. From the Table it is also observed that the treatment improves the performance of the three ability levels.

Testing Hypothesis One

There is no significant difference in the mean academic performance scores of students of varied ability level taught Biology using problem-solving strategies and those taught using lecture methods.

The Post-test scores of the Experimental Group and Control Groups were subjected to Analysis of Covariance (ANCOVA). And in order to determine which group differs significantly among the two methods, Bonferroni Post-hoc analysis was done and Summary of the analysis are shown in Table.

Table 2: Post-Hoc Analysis: Pairwise Comparison of Students' Performance in Problem-Solving and Lecture Method.

(I) Treatment Experimental group	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.[b]
	Problem-solving	0-2.17*	0.30	0.000
	Control	0-.44	0.47	1.000
	Problem-solving	2.17*	0.30	0.000
	Control	1.74*	0.47	0.001
	Problem-solving	0.44	0.47	1.000
	Control	-1.74*	0.47	0.001

Table 2. which showed the Post-hoc analysis, revealed that the p-values of .000 and .001 for problem-solving strategy against control group is less than .005. This is an indication that difference exists in the academic mean scores of students taught using Problem-solving strategy and control group, in favour of problem-solving strategy.

Research Question 2

What are the differences in the mean attitude of students of high, middle and low ability level taught Biology using problem-solving teaching strategy?

Data generated through Students Attitude Questionnaire and Post-test data of Experimental Group were subjected to descriptive statistics of Means and Standard error, were calculated and the result is shown in Table 3.

Table 3: Mean and Standard Error of Attitude of Students of varied ability Taught using Problem-solving strategy.

Group	N	Mean	Std. Error	Mean Difference
Problem-solving	75	20.29	.56	1.09
Control	50	19.20		

Table 3. revealed that differences exist in the mean attitude of students taught using Problem-solving strategy ($\bar{X}=$ 20.29) and lecture method ($\bar{X}=$ 19.20) with Problem-solving having the higher score, compared to control. The result

also, revealed that the mean difference between problem-solving strategy and control group is ($\bar{X}=$ 1.09) in favour of problem-solving.

Testing Null Hypothesis Two
There is no significant difference in the attitude scores of students taught biology using problem-solving teaching strategy.

The Post-test Scores of SAQ in Experimental group and the Control group were subjected to Kruskal- Wallis Test as shown in Table 4.

Table 4: Kruskal-Wallis Test on Students' Attitude

Variable	Group	N	$\overline{X}$ rank	Df	Df	H-cal	P
Attitude	Problem-solving	75	83.45	2	15.90	0.000	Sig
	Control (Lecture method)	50	80.24				

Significant at P ≤ 0.05

Table 4. Result on Kruskal-Wallis test reveals that there is significant difference in the mean attitude scores (H-cal = 15.90, P = .000) of students taught Biology using Problem-solving teaching strategy (mean rank = 83.45) and those taught using lecture method (mean rank = 80.24). Since the P-value is less than 0.05, the null hypothesis is therefore rejected. This implies that there is a significant difference in the attitude of students taught Biology using problem-solving teaching strategy and lecture method in favour of problem-solving.

Research Question 3
What are the differences in the mean academic performance scores of male and female students taught biology using problem-solving teaching strategy?

The Post-test scores of Experimental Group was used and subjected to descriptive statistics. Means and Standard Deviation (SD) were computed/calculated. Summary of the analyses are presented in the Table 5

Table 5: Means and Standard Deviation of Post-Test Scores of Male and Female Students Taught Biology using Problem-Solving Strategy.

Treatment	Gender	Mean	Std. Error	Mean Difference
Problem-solving	Male	14.81[a]	0.31	0.89
	Female	15.50[a]	0.32	

Result in Table 5, shows that differences exist in the mean scores of male and female students taught Biology using problem-solving teaching strategy and those taught using lecture methods. The mean difference between male and female in problem-solving group is 0.89 which is higher for female students. The result also indicated that female students with low ability level had higher mean score than male with the mean differences of 0.32 and 0.31 respectively.

Testing Null Hypothesis Three
There is no significant difference in the mean academic performance scores of male and female students taught biology concept using problem-solving teaching strategy and those taught using lecture methods.
In order to determine whether gender is statistically significant, a 2-Way Analysis of Covariance (ANCOVA) was conducted as shown in Table 6.

Table 6: Means and Standard Deviation of Post-Test Scores of Male and Female Students Taught Biology Using Problem-Solving.

	Gender	Mean	Std. Error	Mean diff	95% Confidence Interval Lower Bound	Upper Bound
Pretest	Male	12.363[a]	0.296	0.453	11.777	12.949
	Female	12.816[a]	0.264		12.293	13.339
Post-test	Male	15.166[a]	0.342	0.112	14.489	15.842
	Female	15.054[a]	0.358		14.345	15.763
Post-post Test	Male	17.919[a]	0.666	2.358	16.599	19.238
	Female	20.277[a]	0.719		18.854	21.701

Result in Table 6, showed the summary of Analysis of Covariance (ANCOVA) of male and female students' Performance in Biology after treatment in experimental group (problem-solving) and (Control group). The results revealed that gender is not statistically significant, $F_{(1,120)} = 1.81$, $p > 0.05$. Also, a 2-Way ANCOVA showed that gender and treatments are not statistically significant, $F_{(1,120)} = 1.39$, $p > 0.05$. Therefore, the null hypothesis is retained, neither the males nor the females performed significantly better than the other in the two groups. This implies that sex does not determine academic performance of students.

Discussion of the Findings

The result of testing the hypotheses showed that there is a significant difference in the mean scores performances of students of different abilities taught Biology using problem-solving teaching strategy compared with their counterparts taught with lecture method. Thus, the finding is in agreement with the study conducted by Afolabi and Akinbobola (2009) who recorded a significant difference among SS2 students with low ability level taught using problem-based teaching technique when compared with those taught with conventional lecture method. The finding is also in line with the work of Osuafor and Okigbo (2013) who reported a significant difference in achievement of SSI students taught Biology with different instructional strategies and also that of Ojediran, Oludipe and Ehindero (2014) who also reported that, there was significant difference in the achievement in Physics of low performing students exposed to laboratory based instructional intervention (LBII) when compared with those exposed to conventional teaching method (CTM).

The ANCOVA of students' performance in Biology on treatments and low ability level was calculated. The result of the analysis indicated that the effect of treatments on students' performance in Biology is statistically significant. Consequently, the null hypothesis which states that there is no significant difference in the mean scores of students of low ability taught Biology using problem-solving strategy and those taught using lecture method is therefore rejected. The findings of this study agreed with Bichi, (2012 and 2013) who reported that there was significant difference in the mean scores of students exposed to problem-solving when compared with those taught with conventional method.

Reports have also shown positive influence on academic performance of students using problem-solving and laboratory strategies in teaching when compared to lecture method (Afolabi and Akinbobola 2009; Ajaja, 2013; Ibe, 2013; Seyhan, 2015; Obeka, 2016).

The results of the study indicated that there was a significant difference in the attitudes of students taught using problem-solving strategies and lecture method with problem-solving strategy having the highest scores, while control group had the lowest scores. The finding confirms the work of Osuafor and Okigbo (2018) who conducted similar study in Akwa Anambra State, and observed that laboratory based instructional method improved the attitude of SSII Biology students. The result is in agreement with that of Ojediran, Oludipe and Ehindero (2014), who also conducted a similar study in Physics in Osun State and reported that laboratory strategy Therefore, the null hypothesis is retained. The finding of this study is however in accordance with those of Adu and Sheyin (2018) and Amedu, (2015) who reported that there was no significant difference in the mean scores of male and female students taught with different instructional methods, however, contradicted the report of Abduraheem, (2012) who revealed that males performed better than females in integrated science in Junior Secondary Schools and affirmed that males demonstrated significantly more positive attitudes towards science than females. Owuamanam and Babatunde (2017) also noted that females exhibit more positive attitudes towards Biology and males towards Physics.

Conclusions

Problem-solving teaching strategy in form of activities oriented such as hands-on-minds-on, learning by doing,

improved the academic performance and attitude of students in physics. The result indicated that students with low ability performed better and develop positive attitudes towards Biology concept when taught with problem-solving strategy such as activities that involves do it yourself, hands-on-minds-on and learn by doing activities than those taught using lecture method. The finding of this study confirms that of Lakpini (2016) which reported that using PIPS and CCIS Model to teach genetics concepts improved the academic performance and attitude of low ability SSII students in Zaria.

Results from the study also indicates that gender and treatments are not statistically significant, thus the treatment is gender friendly hence gender does not have strong influence in the understanding of students in the experimental and control groups.

do it yourself, enable students to participate in class activities and subsequently improve academic performance and attitude towards Biology. However, the strategy does not have strong influence in gender performance, thus, the instructional strategy is gender friendly.

Recommendations

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

➢ The use of problem-solving teaching strategy by hands-on-minds-on activities, learn by doing and do it yourself should be encouraged among secondary school Biology teachers by school administrators and education agencies.

➢ Government agencies such as Federal and State Ministry of Education and other stakeholders in educational sector should provide

adequate and relevant materials in schools where they are not available for effective utilization of problem-solving strategy to enhance meaningful learning.

➢ Biology students in SSS level should be given the opportunity and guided by the teacher or laboratory technologist on how to handle and manipulate some materials and equipment in biology laboratory.

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