
EFFECT OF PROBLEM-BASED LEARNING APPROACH ON SECONDARY SCHOOL STUDENTS' INTEREST AND ACHIEVEMENT IN ELECTRICITY IN BAUCHI STATE, NIGERIA

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ABSTRACT

The study examined the effect of Problem Based Learning Approach on senior secondary school students' interest and achievement in physics in Bauchi State Nigeria. Two research questions and two null hypotheses guided the study. The study adopted a quasi-experimental research design, which was a non-randomized pre-test post-test research design. The population of the study comprised of 4,500 senior secondary one (SS I) students offering Physics in all the 15 senior secondary schools located within Bauchi metropolis. Purposive random sampling technique was used to select four intact science classes from two equivalent co-educational secondary schools that were distantly located from each other within Bauchi metropolis. The instruments used for the data collection were Physics Achievement Test (PAT) and Electricity Interest Inventory (EII). The internal consistency of the instruments was established using Cronbach Alpha for the EII and its internal consistency was gotten as 0.61 and the internal consistency of the PAT was gotten as 0.76 using the Test Retest method to establish the reliability. Data collected for the study was analysed using ANCOVA and the results showed that the PBL approach had a more positive effect on students' interest than the conventional approach. The results also showed that the PBL approach had a more positive effect on students' achievement than the conventional approach. It was found that male students had a slightly higher mean interest rate when they learnt electricity using PBL approach than their female counterparts but the difference was not statistically significant. From the findings of the study, it was recommended among others that Physics teachers should endeavour to develop and adopt the use of PBL approach in physics learning.

Key words: Problem Based Learning, Achievement, Interest, Physics.

INTRODUCTION

Physics plays a predominant role in the scientific development of any nation as it has been identified as the bedrock of scientific and technological development. Physics generates fundamental knowledge needed for the future technological advances that will continue to drive the economic engines of the world. Physics is an important element in the education of

chemists, engineers and computer scientists as well as practitioners of the other physical and biomedical sciences. It extends and enhances our understanding of other disciplines such as earth science, agriculture, chemical, biological and environmental sciences plus astrophysics and cosmology (Martinás & Tremmel, 2014).

The objectives of the physics curriculum as stipulated by the Federal Ministry of Education (2008a) is

to provide basic literacy in physics for functional living in the society; acquire basic concepts and principles of physics as a preparation for further studies; acquire essential scientific skills and attitudes as a preparation for technological applications of physics and to stimulate and enhance creativity. In spite of the importance and usefulness of physics in the scientific and technological development of the nation, research findings and reports from the West African Examination Council (WAEC) have shown that students' achievement in the subject is poor (Afolabi & Akinbobola, 2009; Agummuoh & Ifeanao, 2013; Udoh, 2012; West Africa Examination Council (WAEC), 2010-2015).

Achievement according to Hornby (2006) can be defined as a thing that somebody has done successfully, especially using their own effort and skill. Achievement can also be said to be an accomplishment of knowledge attained. Interest in physics is also instrumental to students' high achievement in physics examinations (Chen, 2001). Chen and Ennis (2004) state that interest is a motivational construct that influences students' engagement and achievement in learning. Research findings by Esiobu and Agwagah as cited in Agummuoh and Ifeanao (2013) states that students have been exhibiting dwindling interest in physics and students' achievement in physics public examinations over the years has been consistently poor. Erinoshio (2013) states that in Nigeria, the evidence of low enrolment and massive failure in public examinations such as the West Africa Senior Secondary School Certificate Examination (WASSSCE) and National Examinations Council (NECO) in physics is indicative that many students have difficulty learning the subject.

The physics curriculum at the secondary school level as specified in the curriculum given by Federal Ministry of Education (2008b) is broken down into mechanics, heat, waves, motion, light, electricity and atomic physics. Among the various aspects of physics contained in the curriculum, electricity is one aspect of

physics that WAEC Chief Examiner reported that students find difficult. According to the West Africa Examination Council (WAEC) (2010-2015) Chief Examiners' Report, it was observed that students avoid questions on electricity while the few students that attempted questions on electricity achieved poorly. The report further states that every year questions on electricity (both objectives, practical and essay) are given and students achievement on those questions has been consistently poor.

Electricity is one aspect of physics that have been identified by students as difficult and abstract in nature due to its mathematical content (Tumba & Wada as cited in Okoronka and Wada (2014). Various researchers such as Okoronka and Wada (2014), Agummuoh and Ifeanao (2013), WAEC Chief Examiners' Report (2010-2015) have reported the low achievement of students in physics particularly electricity on the inappropriate teaching approaches used by teachers which they reported to have result in lack of interest by students in physics. The conventional method of teaching has not yielded much in the field of learning. Over the years various teaching approaches have been employed in teaching electricity and this has not improved students' achievement to an appreciable extent. This problem has necessitated the need to introduce a pedagogical approach that would promote active learning and high achievement among physics students. Hence, in the light of the problems stated above, the researcher adopted an active pedagogical approach for this study, which is the problem based learning (PBL) approach to find out if students' interest and achievement in physics could be improved upon.

Problem based learning approach (PBL) is a student-centred pedagogy in which students learn about a subject through the experience of problem solving. PBL is the process of acquiring new knowledge based on the recognition of a need to learn. The role of the teacher in PBL classroom is to facilitate learning by supporting, guiding and monitoring the learning process.

Researches conducted by other researchers such as Ajai and Imoko (2015), Anyafulude (2014) and Mergendoller, Maxwell, and Bellissimo (2002) showed that PBL is a non-gender discriminatory instructional approach especially in terms of enhancing students' interest and achievement in their subjects of study. This is due to the fact that PBL help students to collaborate and gain from one another in the learning process.

Gender refers to social differentiation or cultural distinction between male and female and the attribution of certain roles on the basis of differentiation (Abe, Egbon, & Aduloju, 2013). The aim of choosing PBL as a learning approach is to create a learning environment where both genders can actively participate in the learning process and contribute meaningfully to the learning situation (Anyafulude, 2014; Iji, Emaikwu, & Utubaku, 2015; Mergendoller et al., 2002). This is because PBL as a learning approach helps to balance the gender gap that exists in the mode of learning of both male and female students.

Statement of the Problem

The persistent low achievement and lack of interest of students in physics has been a major concern to physics educators and researchers. Several factors have been said to be responsible for this trend among which is the instructional approach used by physics teachers in teaching physics such as the conventional method of teaching, inadequate science process skills, gender stereotype and lack of confidence by students in tackling physics problems, the abstract nature of physics, the mathematical nature of physics and the competitive nature of the subject et cetera. Electricity constitutes about 20% of the physics syllabus of West Africa Examination Council (WAEC) and it has been shown from reports by the chief examiner of physics that students avoid questions on electricity and those that attempted questions on electricity achieved poorly.

Purpose of the Study

The purpose of this study was to ascertain the efficacy of Problem Based Learning approach and how it would improve senior secondary school students' interest and achievement in electricity. This study sought to achieve the following specific objectives:

1. determine whether senior secondary one students' (SS I) interest in electricity would improve due to the use of PBL.
2. determine the interaction effect of gender and method of teaching on senior secondary one students' (SS I) achievement in electricity.

Research Questions

The following research questions were asked to guide the study.

1. What are the mean interest ratings of senior secondary one students that were taught electricity using PBL approach and that taught electricity by conventional method?
2. What is the interaction effect of gender and PBL on senior secondary one students' achievement in electricity?

Research Hypotheses

The following null hypotheses formulated for the study were tested at $\alpha = 0.05$ level of significance.

1. There is no significant difference in the mean interest ratings of senior secondary one students taught electricity using PBL approach and that taught electricity using conventional method.
2. There is no significant interaction effect of gender and PBL on senior secondary one students' achievement in electricity.

METHODOLOGY

The research design adopted for the study was a quasi-experimental research design, which is a non-randomized pre-test post-test research design. The study was carried out in Bauchi Metropolis of Bauchi State,

Nigeria. Bauchi State is one of the 36 States in the Federal Republic of Nigeria with Bauchi as her capital. The state lies between longitude 9.84°E and latitudes 10.31°N with an elevation of 616m. She is bordered by seven states, which are Kano and Jigawa States to the North, Taraba and Plateau States to the South, Gombe and Yobe States to the East and Kaduna State to the West. She has 20 Local Government areas with a population of 2, 178, 683 million with total land area of 49, 119km² representing 5.3% of Nigeria’s total land mass (Cometonigeria staff, 2011).

The population of the study comprised of all the senior secondary one (SS I) students offering Physics in all the senior secondary schools located within Bauchi metropolis. The population of the students is 4500 SS. I students in 15 Government secondary schools located within Bauchi metropolis (Source: Bauchi State Ministry of Education, 2015).

The sample for the study consists of 226 students drawn from two equivalent co-educational secondary schools that are distantly located from one another within Bauchi metropolis. It comprised of 108 female students and 118 male students. Purposive sampling technique was used to select two schools from the 15 schools. The researcher made use of intact classes in each of the two schools that were purposively selected. The schools were randomly assigned to experimental and control groups in a manner that each of the schools has equal and independent chance of been included in the study.

The instruments used for the data collection was Physics Achievement Test (PAT) and Electricity

Interest Inventory (EII). PAT comprised of 30 multiple choice questions (MCQ) and EII comprised of 30 interest items on a four-point rating scale which anchored on continuum of strongly agreed (SA = 4), agree (A = 3), disagree (D = 3) and strongly disagreed (SD = 1).

The two adapted instruments were given for face and content validation to two physics educators, two physics teachers and one expert in measurement and evaluation, making it a total of five validators. The lesson plans, research questions and hypotheses was also given to enable them carry out objective validation of the test questions and interest inventory.

The internal consistency of the instruments was established using Cronbach Alpha (α) for the EII and its internal consistency was gotten as 0.61 while the internal consistency of the PAT was gotten as 0.76 using the Test Retest method to establish the reliability. The scores were calculated using the Pearson correlation coefficient. Data collected was analysed using descriptive statistic of mean and standard deviation to answer the research questions. The research hypotheses were tested using inferential statistic of Analysis of Covariance (ANCOVA) at significance level of $P \leq 0.05$.

RESULTS AND DISCUSSIONS

Research Question 1

What are the mean interest ratings of senior secondary one (SS I) students taught electricity using PBL approach and those that were taught electricity by conventional method?

Table 1: Mean and Standard Deviation of SS I Interest Rating of Students taught electricity using PBL approach and those that were taught electricity by conventional method

Teaching Approach	N	Pre-test		Post-test	
		Mean	SD	Mean	SD
Problem Based Learning	101	2.59	0.47	2.87	0.53
Conventional Method	125	2.52	0.35	2.72	0.35
Mean Difference		0.07		0.15	
Total	226				

Results in Table 1 show that the group taught electricity using the problem based learning (PBL) approach had a pre-test interest mean rating of 2.59 with a standard deviation of 0.47 and a post-test interest mean rating of 2.87 with a standard deviation of 0.53. The group taught electricity using conventional approach had a pre-test mean interest rating of 2.52 with a standard deviation of 0.35 and a post-test mean interest rating of 2.72 with a standard deviation of 0.35. However, for each of the

groups, the post-test mean interest ratings were greater than the pre-test mean interest rate, with the group taught electricity using PBL approach having a higher mean interest gain.

Research Question 2

What is the interaction effect of gender and PBL on senior secondary one students' achievement in electricity?

Table 2: Mean and Standard Deviation of Respondents on the Interaction Effect of Teaching Approach and Gender on Students' Achievement in Electricity.

Method of Teaching	Gender	N	Pre-test		Post-test	
			Mean	SD	Mean	SD
PBL Approach	Male	36	23.03	7.48	53.31	7.55
	Female	65	29.60	7.61	59.55	7.62
Mean difference			6.87		6.24	
Conventional Approach	Male	82	26.12	7.84	50.56	7.75
	Female	43	26.97	7.65	46.48	7.54
Mean difference			0.85		4.08	

Results in Table 2 show the interaction effect of gender and teaching approach on students' achievement in electricity. Results show that the male students taught electricity using PBL approach had a pre-test mean achievement score of 23.03 with a standard deviation of 7.48 and a post-test mean achievement score of 53.31 with a standard deviation of 7.55. The female students taught electricity using PBL had a pre-test mean achievement score of 29.60 with a standard deviation of 7.61 and a post-test mean achievement score of 59.55 with a standard deviation of 7.62. Table 7 also shows that male students taught electricity using conventional approach had a pre-test mean achievement score of 26.12 with a standard deviation of 7.84 and a post-test mean achievement score of 50.56 with a standard deviation of 7.75. The female students taught electricity using conventional approach had a pre-test mean achievement score of 26.97 with a standard deviation of 7.65 and a

post-test mean achievement score of 46.48 with a standard deviation of 7.54.

In both cases, the post-test mean achievement scores were greater than the pre-test mean achievement with the female students having a higher achievement mean score of 59.55 and a mean difference of 6.24 in PBL. The effect size was also considered as indicated by the corresponding partial eta squared value which is 0.07. This value indicates how much of the variance in the dependent variable is explained by the independent variable. Converting the partial eta squared value to percentage by multiplying by 100, it gives 7%.

Hypothesis 1

There is no significant difference in the mean interest ratings of senior secondary one students taught electricity using PBL approach and those that were taught electricity by conventional method.

Table 3: Analysis of Covariance (ANCOVA) Result of the Mean Interest Ratings of Students Taught electricity using PBL approach and those taught electricity by conventional method.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1.271 ^a	4	.318	1.593	.177
Intercept	42.634	1	42.634	213.790	.000
Pre-test Int.	6.933E-005	1	6.933E-005	.000	.985
Treatment	1.216	1	1.216	6.098	.014
Gender	.012	1	.012	.060	.807
Treatment * Gender	.001	1	.001	.005	.943
Error	44.071	221	.199		
Total	1808.233	226			
Corrected Total	45.342	225			

Table 3 shows that with respect to mean interest ratings of students taught electricity using PBL approach and those that were taught electricity by conventional approach, $F(1, 221) = 6.098$, $P > 0.05$. Therefore, the null hypothesis which state that there is no significant difference in the mean interest ratings of senior secondary one students that learnt electricity using PBL approach and those that were taught electricity by conventional method was rejected. Inference drawn therefore is that, there was a significant difference in the mean interest ratings of senior secondary one students

taught electricity using PBL approach and those that were taught electricity by conventional method. The students taught electricity using PBL approach had a higher mean rating in the post-test. This result showed that the PBL approach resulted in an improvement in students' interest in electricity than the conventional approach.

Hypotheses 2

There is no significant interaction effect of gender and PBL on senior secondary one students' achievement in electricity.

Table 4: Analysis of Covariance (ANCOVA) Result of the interaction effect of gender and PBL on senior secondary one students' achievement in electricity.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	7160.981 ^a	4	1790.245	36.238	0.000	0.396
Intercept	30319.355	1	30319.355	613.728	0.000	0.735
Pre-test Achi.	2062.803	1	2062.803	41.755	0.000	0.159
Treatment	3254.440	1	3254.440	65.877	0.000	0.230
Gender	7.149	1	7.149	.145	0.704	0.001
Treatment * Gender	799.726	1	799.726	16.188	0.000	0.068
Error	10917.837	221	49.402			
Total	648363.000	226				
Corrected Total	18078.819	225				

The result in Table 4 shows that with respect to the interaction effect of gender and PBL on students' achievement in electricity, $F(1, 221) = 16.188$, $P < 0.05$. Therefore, the null hypothesis which states that there is no significant interaction effect of gender and PBL on senior secondary one students' achievement in electricity is rejected.

The effect size was also as indicated by the corresponding partial eta squared value which is 0.07. This value indicates how much of the variance in the dependent variable is explained by the independent variable. Converting the partial eta squared value to a percentage by multiplying by 100, it gives 7% which means the research is able to explain only 7% of the variance. Inference drawn therefore is that, the interaction effect of gender and PBL on senior secondary one students' achievement in electricity is statistically significant.

SUMMARY OF THE FINDINGS

From the data analysis and interpretation of the results, the following findings emerged;

1. The result of the study showed that PBL approach had a more positive effect on students' interest than the conventional approach.
2. The finding of the study showed that the interaction effect of gender and PBL on senior secondary one students' achievement in electricity is statistically significant.

CONCLUSION

Based on the findings of the study, the researcher drew the following conclusions. The use of PBL approach in teaching electricity had a more positive effect on students' interest in physics than the conventional approach and the interaction effect of gender and PBL on senior secondary one students' achievement in electricity is statistically significant.

RECOMMENDATIONS

The following recommendations have been made based on the findings of this study.

1. Physics teachers should be encouraged to adopt PBL approach in physics classroom. This is because when properly used, it will enhance the overall interest and achievement of students in physics as well as help reduce gender gap in science generally.
2. The use of PBL approach should be adopted as a learning approach and incorporated into the curriculum as a pedagogical approach for active learning among students.

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