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Effect of problem-based learning strategy on upper basic education Students interest, achievement and cognitive load in basic science in Katsina-ala local government area

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Abstract
The study investigated the effect of Problem-Based Learning Strategy on Upper Basic Education Students Interest, Achievement and Cognitive Load in Basic Science in Katsina-Ala Local Government Area. The study adopted a Quasi – experimental design of Pre-Test, Post –Test control group. The target population of the study was 682 upper Basic two Students in all the Secondary Schools in Katsina-Ala Local government Area. A sample of 101 upper Basic two (2) Basic Science Students participated in the study. Stratified Simple Random Sampling was used to select four schools while Simple Random Sampling was used to assign two intact classes each to experiment and control groups. Six (6) research questions were asked and six (6) null hypotheses were formulated to guide the study. Data were collected using three instruments titled: Basic Science Interest Inventory (BS11), Basic Science Achievement Test (BSAT) and Cognitive Load Rating Scale (CLRS). All the instruments were validated by four (4) experts. The reliability coefficient of BSII was 0.81 estimated using Cronbach Alpha, BSAT was 0.86 estimated using Kurder Richardson formula K-20 and CLRS was 0.63 estimated using Cronbach Alpha. Mean and Standard Deviation were used to answer the research questions while analysis of covalence (ANCOVA) was used to test the null hypotheses at 0.05 level of significance. The finding of study revealed among others that Students taught PBLS recorded higher interest, achievement and expanded their low cognitive load compare to their counterparts taught using lecture method. Based on the findings, it was recommended among others that teachers should adopted PBLS in teaching Basic Science to improve students' interest, achievement and to reduce their cognitive load.

Keywords: Problem-Based Learning Strategy, Interest, Achievement, Cognitive Load and Gender

Introduction

The Nigerian educational system is facing a lot of challenges. The most striking one is that many Nigerian students do not possess the depth of knowledge and skills to ensure national economic development (Oludipe & Oludipe, 2010) [48]. This means that many students cannot engage in complex problem-solving activities and apply school knowledge and skills to real life situations in their places of work. The second challenge is poor achievement in science, especially in basic science among upper basic students (Obomanu, 2011). According to Ochu & Haruna, (2015) [46], this poor achievement in basic science by students has led many of them to the arts or social science due to insufficient prerequisite science subjects leading to low enrolment in the science. This creates a gap in national development.

Basic Science, formerly known as Integrated Science is the first form of science a child encounters at the secondary school level. This prepares students at the upper basic level for the study of core science subjects (Biology, Chemistry and Physics) at the Senior Secondary (SS) level (Oludipe, 2012) [49]. Basic Science education being the bedrock for subsequent specialist science study plays a vital role in the lives of individuals and the development of a nation scientifically and technologically (Bukunola & Oludipe, 2012) [49]. He added that the door way to the survival of a nation scientifically and technologically is scientific literacy which can be achieved through science education. This means that, for a student to be able to study single science subjects at the Senior Secondary (SS) level successfully, such a student has to be well grounded in Basic Science at the upper basic level.

Basic Science being a foundational subject in the school science curriculum, might have some concept to be learned which contain high elements of inter-activity that is complex for students to understand and inability to comprehend these materials could result to low interest and poor achievement (Okwori, 2014) [47]. Consequently, there is an observable drastic and constant reduction in the level of interest and achievement in Science.

Which is also applicable to Mathematics by students at all levels of education in Nigeria. (Obomanu, 2011 & Emaikwu, 2012b) [24]. In the same vain Ochu & Haruna (2015) [46], revealed that this low interest and poor achievement in Basic Science is because of poor condition of service for teachers; such as lack of qualified teachers, lack of instructional materials, wrong method of teaching; different ability level of students; lack of funds; lack of good and standard laboratories among others (Obomanu, 2011; Ochu & Haruna, (2015) [46]. On the contrary viewed Oludipe & Oludipe (2010) [48], revealed that persistent poor achievement in science, lack of complex problem-solving skills and knowledge levels among students suggest that the current educational paradigm is weak or inappropriate. As a result of low interest and poor achievement in science, educators and other institutions directly involved in the educational system need to understand that changes in student's outcome should be supported by changes in instructional method and assessment method to improve students interest and achievement (Emaikwu, 2012a) [23].

Interest is the expression of feeling that you have when you want to know or learn about something. Recently, a number of countries have expressed concern that interest in science and technology studies is declining even as demand for science and technology graduate grows. According to Itodo, (2019) [35] students learning process is initially based on teachers teaching. Without teachers scientific and effective instruction students will never possess interest in certain knowledge. An important aspect of Basic Science teaching is to create an atmosphere of complete participation in which the students can perceive the learning of Basic Science from positive and initiative stance in co-operative way. As the student draw a conclusion by active exploration, a pleasure of success comes into being. The students feel proud of their success which can further foster their confidence in learning and inspiring their interest in the study of Basic Science. Once students' interest is inspired, they are more motivated to learn. This will in no small measure improve student's attainment of the behavioural objectives and consequently the goals of the curriculum.

Keeping students engaged and interested in the classroom is an essential factor in successful teaching and learning of Basic Science. Bechtel (2013) [9] maintain that the approach of sustaining student's interest seems obvious to Basic Science teachers. However, Basic Science teachers need to get students interested in Basic Science lesson and these will motivate students to engage in classroom activities. In the end teaching them becomes much ensure. Personal experience revealed to us that capturing student's interest and keeping them engaged is not so simple, especially when what they need to learn involves lots of information and complicated associations. This Basic Science teacher should make concerted effort to engage students in learning activities that will ginger their interest in Basic Science.

In the same vein Adam (2013) [3] assets that the declining interest of students in Basic Science is very often attributed to the uninteresting manner in which the content is presented to the learners and some difficult content of Basic Science courses. By this there is need to employ the problem-based learning strategy whether it will foster students interest in basic science.

Apart from interest another issue of concern to educators in Nigeria, is student's achievement. According to Abakpa (2011) [2], achievement is the student's actual record or level of accomplishment in a specific field of study. The author further stressed that academic achievement is the measure of what students have learned through assessment like standardized test performance assessment and portfolio assessment. In the context of this study academic achievement is the measure of the context to which students reach the stated objective. Meanwhile, the researcher observed that the academic achievements of students in both internal and external examinations are dwindling rapidly. This might be the reasons while Emaikwu (2012) assessing the relative effectiveness of three teaching methods in the measurement of students achievement in mathematics noted that the poor achievement of senior secondary school students in science subject at both the internal and external examinations have been awfully reported and acknowledge by all and sundry in Nigeria as poor. According to the author, the low achievement of students in the secondary schools is controvertibly attributed to the use of ineffective methods of teaching adopted by the teacher. It is very clear that the poor academic achievement of students in basic science is not caused by one factor but many, which ranges from students factors, parental factor, environmental factor, school administration to teachers factor like teachers competence and method of teaching. Considering the importance of method of teaching in education it suffice to say that, the method of teaching is the first to be rated in discussing students achievement and cognitive load.

Cognitive load is the term commonly used in the field of education to describe the amount of work imposed on a students working memory (Chaudbry, 2013). It is the amount of "brain power" required to understand something. This could be perception, problem solving or judging things in memory (Towers, 2010) [69]. As a matter of fact, environment and level of knowledge can affect cognitive load in students which can reduce their academic interest and achievement. The perception of cognitive load is not the same in every student. Students often perceive cognitive load because of increase in distractions of various levels, ranging from personal interruption to the use of facebook and other social forms of communication that is why Sweller (1988) [62] in his theory of cognitive load argued, that instructional design can reduce cognitive load in learners. Sweller's cognitive load theory, (1988) [62] contend that during complex learning activities the amount of information and interactions that must be processed simultaneously can either underload or overload the finite amount of working memory one possesses. For this reason, instruction should be aimed at teaching the learners problem solving skills, thinking and reasons skills. This can help learners to learn better when they can build on their previous knowledge (existing schema). Cognitive load theory has been designed to provide guidelines intended to assist in the presentation of information in a manner that encourages learner activities that optimize intellectual performance (Buettner, 2013) [15]. According to Sweller (2010) [63], there is a limit to the amount of information that can be used, processed and stored by the working memory and overloading this limit undermines the learning process, thereby, constituting cognitive load and reduction in achievement rates of students irrespective of gender.

The results of studies on gender differences are contradicted. Many researches on gender difference in academic interest and achievement in science education had been carried out by different researchers, Itodo (2019) [35]; Agbidye, (2017) [5], found that there are no statistically significant differences in the academic achievements of students in respect to gender. Oludipe (2012) [49] also found that there was no statistically significant difference in the academic achievement mean scores of male and female students, though the male student's academic achievement were a little bit higher than those of the female students. Still some researchers like Aguele & Uhumniah, 2011, Oludipe, 2012 [49] found that male students achieved higher than female students in science. Khwaileh & Zaza (2011) [38] found that female students outperformed the male students. This revealed an unresolved controversy which this study seeks toinvestigate. This study will be carried out to look at the effect of problem-based learning strategy on the upper basic students' interest, achievement and cognitive load in Basic Science.

Statement of the Problem

Basic science is a subject taught in Nigeria upper basic schools and it is one of the core subject (NPE 2014). The importance of the subject cannot be over stated, for instance, the knowledge of basic science helped to prepare students for study of science subject at senior secondary school level, the knowledge of basic science help man in the conservation of natural resources. Basic science also is pre-requisite to other discipline such as chemistry, physics, and biology among others. Despite these benefits of basic science, there is a continuous poor achievement of students in the subject. This poor achievement become eminent when one considers the performance of students in Basic Education Certificate Examination (BECE) conducted in Benue state. This poor trend is particularly evident in the achievement of basic science students who over the years have not recorded an average of 50% pass in the examination. The poor achievement and low interest may be due to the method of teaching (Itodo, 2019) [35]. Furthermore Agbidye (2017) [5] opines that the poor achievement may be due to cognitive load of study materials by students. This persistence poor achievement, low interest and cognitive load in basic science makes it imperative to search for better learning strategy that will enhance students interest, achievement and can reduce students cognitive load. With this in mind, the researcher is set to investigate what could be the effect of Problem–Based Learning Strategy on upper Basic students Interest, Achievement and Cognitive Load in Basic science and if this learning strategy is gender biased.

Objectives of the Study

This study is to investigate, the effect of Problem-Based Learning Strategy on Upper Basic Students Interest, Achievement and Cognitive Load in Basic Science. Specifically, the study sought to:

1. Find out if there would be a difference in the mean interest scores rating of Upper Basic Education Students taught Basic Science using Problem-Based Learning Strategy and Lecture Method.
2. Find out if there would be a difference in the mean achievement scores of Upper Basic 2Students taught Basic Science using Problem-Based Learning Strategy and Lecture Method.
3. Find out the mean cognitive load rating scores of Upper Basic 2Students taught Basic Science using Problem-Based Learning Strategy and Lecture Method.
4. Compare the mean interest rating scores of male and female Upper Basic 2students when taught Basic Science using Problem-Based Learning Strategy.
5. Determine the mean achievement score of male and female Upper Basic 2Students when taught Basic Science using Problem-Based Learning Strategy.
6. Determine the mean cognitive load rating scores of male and female Upper Basic 2Students when taught Basic Science using Problem-Based Learning Strategy.

Research Questions

The following research questions guided the study:

1. What is the difference in the mean interest rating scores of Upper Basic 2Students taught Basic Science using Problem-Based Learning Strategy and those taught using Lecture Method?
2. What is the difference in the mean achievement scores of Upper Basic 2 students taught Basic Science using Problem-Based Learning Strategy and those taught using Lecture Method?
3. What is the difference in the mean cognitive load rating scores of Upper Basic 2 Students taught Basic Science using Problem-Based Learning Strategy and those taught using Lecture Method?
4. What is the difference in the mean interest rating between male and female Upper Basic 2 Students taught Basic Science using Problem-Based Learning Strategy?
5. How do male and female Upper Basic 2 students differ in mean achievement scores when taught Basic Science using Problem-Based Learning Strategy?
6. What is the difference in mean cognitive load scores for male and female Upper Basic 2 Students when taught Basic science using Problem-Based Learning Strategy?

Hypotheses

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

1. There is no significant difference in mean interest rating scores of upper Basic 2Students taught Basic Science using Problem-Based Learning Strategy and Lecture Method.
2. There is no significant difference in mean achievement scores of Upper Basic 2 Students taught Basic Science using Problem-Based Learning Strategy and Lecture Method.
3. There is no significant difference in mean cognitive load scores of Upper Basic 2 Students taught Basic Science using Problem-Based Learning Strategy and Lecture Method.
4. There is no significant difference in the mean interest rating scores of male and female Upper Basic 2 Students taught Basic Science using Problem-Based Learning Strategy.
5. There is no significant difference in the mean achievement scores of male and female Upper Basic 2Students taught Basic Science using Problem-Based Learning Strategy.
6. There is no significant difference in the mean cognitive load scores of male and female upper Basic 2 Students taught Basic Science using Problem-Based Learning Strategy.

Materials and Methods

The research design for this study is the quasi-experimental design. The study aimed at determining the effect of the use of Problem-Based Learning Strategy and lecture method on the Upper Basic 2 students, interest, achievement and cognitive load in Basic Science in Katsina-Ala Local Government Area of Benue State. Quasi-experimental design seeks to establish the cause and effect relationship of a given treatment (Emaikwu, 2011) [22]. In which case the study adopted the non-equivalent control group, pre-test and post-test design. There was no randomization of subject as this would disrupt school activities. Hence, intact classes of all the arms of Upper Basic 2 in the sample school were randomly assign to the experimental and control groups. The target population of this study was 682 Upper Basic 2 students (male – 404 and female – 278) in 45 secondary schools in Katsina-Ala Local Government Area (Ministry of Education Officer Makurdi, Benue State 2018). The study used a sample size of 101 Upper Basic 2 students in Basic Science. Three research instruments were used for data collection. These are; Basic Science Achievement Test (BSAT), Basic Science Interest Inventory (BSII) and Cognitive Load Rating Scale (CLRS). To ensure that the Instrument measures what it was intended to; a table of test blueprint was constructed for Basic Science Achievement Test (BSAT). The Basic Science Interest Inventory (BSII) and Cognitive Load Rating Scale (CLRS) were validated by four experts. One expert in Measurement and Evaluation, Department of Educational Foundations and General Studies, Federal University of Agriculture, Makurdi. Two experts, in the Department of Science Education, Benue State University, Makurdi. Another one experience Basic Science teacher Government model Makurdi. A pilot study was carried out to test the reliability of the research instruments. The trial testing of basic science achievement test, basic science interest inventory and cognitive load rating scale was conducted on 35 students of basic science Upper Basic 2 of Government Model Secondary School, Makurdi, Benue State who are outside the study area but have the same characteristics with the study area and the scores were used to do items analyses of the instrument. The Statistics Packages for Social Science (SPSS Version 2015) was used to calculate reliability coefficient. The reliability coefficient for BSAT was found to be 0.81 using Kurder Richardson formula [K-R_{20}]. The reliability coefficient for BSII was calculated using Cronbach Alpha which was found to be 0.86.The reliability coefficient for CLRS also calculated using Cronbach Alpha which was found to be 0.63. The values of reliability coefficient for BSAT, BSII and CLRS showed an acceptable level of internal consistencies of the instruments as the value was greater than 0.50. The experimental procedure lasted for 6 weeks. Means and Standard Deviation was used for answering all the research questions. Inferential statistics of Analysis of Covariance (ANCOVA) was used to test hypotheses at 0.05 level of significance.

Results

Research Question One

What is the difference in the mean interest rating of Upper Basic 2 Students taught Basic Science using Problem-Based Learning Strategy and those taught using Lecture Method?

Table 1: Mean interest rating scores and standard deviation of groups taught Basic Science using Problem-Based Learning Strategy and those taught using Lecture Method

Teaching Approach	No. of Students	Mean Scores		Standard Deviation		Mean gain
		Pre-Test	Post-Test	Pre-Test	Post-Test	
PBLS	51	2.02	3.34	0.47	0.29	1.32
Lecture Method	50	2.11	2.62	0.44	0.41	0.51
Mean Difference		-0.09	0.72			0.81
Total	101					

KEY: PBLS = Problem Based Learning Strategy

Data in table 1 shows that the pre-test mean interest rating scores for the treatment group is 2.02 with a pre-test Standard deviation of 0.47 while a post-test mean interest rating score is 3.34 with post-test standard deviation 0.29. The pre-test mean interest rating score for the control group is 2.11 with a pre- test standard deviation of 0.44 while the post-test mean interest rating score is 2.62 with a post-test standard deviation of 0.41. Respectively the group taught basic science using Problem –Based Learning Strategy has a higher mean difference score of 1.32 than those taught using lecture method which has a mean difference score of 0.51. The overall mean difference between the groups was 0.81 in favour of students taught using Problem-Based Learning Strategy. This means that the mean interest rating of students taught Basic Science using Problem-Based Learning Strategy was higher than those taught using lecture method.

Research Question Two

What is the difference in the mean achievement scores of Upper Basic 2 Students taught Basic Science using Problem-Based Learning Strategy and those taught using Lecture Method?

Table 2: Mean Achievement scores and standard deviation of groups taught Basic Science using Problem-Based Learning Strategy and those taught using Lecture Method

Teaching Approach	No. of Students	Mean Scores		Standard Deviation		Mean gain
		Pre-Test	Post-Test	Pre-Test	Post-Test	
PBLS	51	14.74	35.03	3.74	2.34	20.29
Lecture Method	50	15.66	27.80	2.59	3.20	12.14
Mean Difference		-0.92	7.23			8.15
Total	101					

KEY: PBLS = Problem Based Learning Strategy

Data in table 2 shows that the pre-test mean achievement scores for the treatment group is 14.74 with a pre-test Standard deviation of 3.74 while a post-test mean achievement score is 35.03 with a post-test standard deviation of 2.34. The pre-test mean achievement score for the control group is 15.66 with a pre- test standard deviation of 2.59 while a post-test mean achievement score is 27.80 with a post-test standard deviation of 3.20. Respectively the group taught basic science using Problem –Based Learning Strategy has a higher mean difference score of 20.29 than those taught using lecture method which has a mean difference score of 12.15. The overall mean difference between the groups was 8.15 In favour of students taught Basic Science using Problem-Based Learning Strategy. This means that the mean achievement of students taught Basic Science using Problem-Based Learning Strategy was higher than those taught using lecture method.

Research Question Three

What is the difference in the mean cognitive load rating scores of Upper Basic 2 Students taught Basic Science using Problem-Based Learning Strategy and those taught using Lecture Method?

Table 3: Mean cognitive load rating scores and standard deviation of groups taught Basic Science using Problem-Based Learning Strategy and those taught using Lecture Method

Teaching Approach	No. of Students	Mean Scores		Standard Deviation	
		Pre-Test	Post-Test	Pre-Test	Post-Test
PBLS	51	4.07	2.20	0.55	0.43
Lecture Method	50	4.10	3.42	0.56	1.15
Total	101				

KEY: PBLS = Problem Based Learning Strategy

Data in table 3 shows that the pre-test mean cognitive load scores for treatment group is 4.07 with a pre-test standard deviation of 0.55, while Post-Test mean cognitive load scores is 2.20 with a Post-Test standard deviation of 0.43. Pre-Test mean cognitive load scores for control group is 4.10 with a Pre-Test standard deviation of 0.56 while the post-test mean cognitive load scores is 3.42 with a post-test standard deviation of 1.15.

From table 3 it was observed that students who were taught Basic Science using PBLS experienced low cognitive load with a post-test mean cognitive load scores of 2.20 while students who were taught Basic Science using lecture method experienced high cognitive load with Post-Testmean cognitive load scores of 3.42. This implies that the students taught Basic Science using PBLS had lower mental effort in learning the concepts taught in basic science than students in the control group who were taught using lecture method.

Research Question Four

What is the difference in the mean interest rating scores between male and female upper basic 2 students taught Basic Science using Problem-Based Learning Strategy?

Table 4: Mean interest rating scores of male and female students taught Basic Science using Problem-Based Learning Strategy

Group	Teaching Approach	Sex	No of Students	Mean Scores Pre-Test	Post-Test	Standard Deviation Pre-Test	Post-Test	Mean gain
Experimental	PBLS	Male	24	2.06	3.30	0.55	0.26	1.24
		Female	27	1.97	3.38	0.38	0.30	1.41
Mean Difference				-0.09	0.08			0.17
Total			51					

KEY: PBLS = Problem Based Learning Strategy

Result in table 4 shows that in Pre-Test the male students in the experimental group had a mean interest rating scores of 2.06 with a standard deviation of 0.55, while a Post-Test mean interest rating scores of 3.30 with standard deviation of 0.26. The Pre-Test mean interest rating scores for the female is 1.97 with a standard deviation of 0.38 while the Post-Test mean interest rating scores is 3.38 with a standard deviation of 0.30. Respectively the female students taught Basic Science using PBLS has higher mean difference scores of 1.41 than the male students taught basic science using PBLS which has a mean difference of 1.24. The overall mean difference between the groups was 0.17 in favour of female students taught basic science using PBLS. This means that the mean interest rating of female students taught PBLS was little bit higher than the male students.

Research Question Five

How do male and female Upper Basic 2 Students differ in mean achievement when taught Basic Science using Problem-Based Learning Strategy?

Table 5: Mean achievement scores of male and female students taught Basic Science using Problem-Based Learning Strategy

Group	Teaching Approach	Sex	No of Students	Mean Scores Pre-Test	Post-Test	Standard Deviation Pre-Test	Post-Test	Mean gain
Experimental	PBLS	Male	24	13.83	35.41	2.91	2.53	21.58
		Female	27	15.55	34.70	4.23	2.16	19.15
Mean Difference				-1.72	0.71			2.43
Total			51					

KEY: PBLS = Problem Based Learning Strategy

Data in table 5 revealed that the male students had a Pre-Test mean score of 13.83 with the standard deviation of 2.91 while a Post-Test mean score of 35.41 with standard deviation of 2.53. The female counterparts had a Pre-Test mean score of 4.23 with the standard deviation of 4.23 while Post-Test mean score of 34.75 with a standard deviation of 2.16. This gives the mean difference of 2.43 in favour of the male students. This implies that the Problem-Based Learning Strategy enhanced the academic achievement of male students slightly higher than that of the female.

Research Question Six

What is the difference in the mean cognitive load rating scores for male and female upper basic 2 students taught Basic Science using Problem-Based Learning Strategy?

Table 6: Mean cognitive load scores of male and female students taught Basic Science using Problem-Based Learning Strategy

Group	Teaching Approach	Sex	No of Students	Mean Scores Pre-Test	Post-Test	Standard Deviation Pre-Test	Post-Test	Mean gain
Experimental	PBLS	Male	24	4.11	2.23	0.57	0.50	1.88
		Female	27	4.03	2.18	0.54	0.36	1.85
Mean Difference				0.08	0.05			0.03
Total			51					

KEY: PBLS = Problem Based Learning Strategy

Data in table 6 shows that the Pre-Test mean cognitive scores for male is 4.11 with a Pre-Test deviation of 0.57 while the Post-Test mean cognitive load scores is 2.23 with a Post-Test standard deviation of 0.50. A Pre-Test mean cognitive load scores for female is 4.03 with Pre-Test scores of standard deviation is 0.54 while the Post-Test mean cognitive load is 2.18 with a Post-Test standard deviation of 0.36. This implies that both male and female students expanded same level of mental effort to learn concepts taught in basic science using PBLS.

Hypothesis One

There is no significant difference in the mean interest rating scores of students taught Basic Science using Problem-Based Learning Strategy and those taught using Lecture Method.

Table 7: Analysis of Covariance (ANCOVA) of student's interest taught basic science using Problem Based Learning Strategy and those taught using lecture method

Source	Type III Sum of squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	13.076a	2	6.538	51.105	.000	.511
Intercept	38.355	1	38.355	299.807	.000	.754
Premier	.058	1	.058	.450	.504	.005
Group	13.055	1	13.055	102.043	.000	.510
Error	12.537	98	.128			
Total	928.923	101				
Corrected Total	25.614	100				

a. R Squared = .511 (Adjusted R Squared = .501)

Result in table7 Shows that the P-value of groups is $F_{(1, 98)}$=102.043 and P=0.000 <0.05 while (partial Eta square=0.510). Since the P- value is less than the α-value the null hypothesis was therefore not accepted. Thus there is significant difference between mean interest rating scores of students taught Basic Science using Problem-Based Learning Strategy and those taught with lecture method. This implies that students taught Basic Science using Problem Based Learning Strategy had more interest in Basic Science than those taught using Lecture Method.

Hypothesis Two

There is no significant difference in the mean achievement scores of students taught Basic Science using Problem-Based Learning Strategy and those taught using Lecture Method.

Table 8: Analysis of Covariance (ANCOVA) of student's achievement taught basic science using Problem Based Learning Strategy and those taught using lecture method

Source	Type III Sum of squares	df	Mean square	F	Sig.	Partial Eta Squared
Corrected Model	1331.498[a]	2	665.749	84.561	.000	.633
Intercept	4592.868	1	4592.868	583.371	.000	.856
Achpretest	8.370	1	8.370	1.063	.305	.011
Group	1267.188	1	1267.188	160.954	.000	.622
Error	771.552	98	7.873			
Total	102037.000	101				
Corrected Total	2103.050	100				

a. R Squared = .633 (Adjusted R Squared = .626)

Result table 8: Shows that P-value of groups is $F_{(1, 98)}$ =160.954 and P=0.000 <0.05 while (partial Eta square=0.622). Since the P- value is less than the α-value the null hypothesis was therefore not accepted. Thus there is significant difference between the mean achievements scores of students taught Basic Science using Problem-Based Learning Strategy and those taught with lecture method. This implies that the students taught Basic Science using Problem Based Learning Strategy achieved more in Basic Science than those taught using Lecture Method.

Hypothesis Three

There is no significant difference in the mean cognitive load scores of students taught Basic Science using Problem-Based Learning Strategy and those taught using Lecture Method.

Table 9: Analysis of Covariance (ANCOVA) for cognitive load of students taught basic science using Problem Based Learning Strategy and those taught using lecture method

Source	Type III Sum of squares	df	Mean square	F	Sig.	Partial Eta Squared
Corrected Model	37.535[a]	2	18.767	24.661	.000	.335
Intercept	12.643	1	12.643	16.614	.000	.145
Precles	.067	1	.067	.089	.766	.001
Group	37.375	1	37.375	49.112	.000	.334
Error	74.578	98	.761			
Total	911.250	101				
Corrected Total	112.113	100				

a. R Squared = .335 (Adjusted R Squared = .321)

Result table 9: Shows that the P-value of group is$F_{(1, 98)}$ =49.112 and P=0.000 <0.05 while (partial Etasquared=0.334). Since the P- value is less than α-value the null hypothesis was therefore not accepted. Thus there is significant difference between mean cognitive load scores of students taught Basic Science using Problem-Based Learning Strategy and those taught with lecture method. This implies that the students taught Basic Science using Problem-Based Learning Strategy had low cognitive load in Basic Science than taught using Lecture Method.

Hypothesis Four

There is no significant difference in the mean interest rating scores of male and female Upper Basic 2 students taught Basic Science using Problem Based Learning Strategy.

Table 10: Analysis of interest rating scores to covariance boys and girls taught basic science using Problem Based Learning Strategy

Source	Type iii Sum of Square	df.	Mean Square	F	Sig
Corrected Model	.165	2	.082	.972	.386
Intercept	25.955	1	25.955	306.142	.000
Pre-in	.069	1	.069	.808	.373
Gender	.112	1	.112	1.318	.257
Error	4.069	48	.085		
Total	575.243	51			
Corrected	4.234	50			

R Square =.039(Adjusted R-Squared =.001)

Result in table 10 Shows that the P-Value of gender is $F_{(1, 48)}$ =1.318 andP= 0.257>0.05.Since the P-value is greater than the α-value,the null hypothesis was therefore accepted. Thus there is no significant different between the mean interest of male and female students taught Basic Science using Problem-Based Learning Strategy.

Hypothesis Five

There is no significant difference in the mean achievement scores of male and female Upper Basic 2 students taught Basic Science using Problem Based Learning Strategy.

Table 11: Analysis of achievement scores to covariance boys and girls taught basic science using Problem Based Learning Strategy

Source	Type III Sum of squares	df	Mean square	F	Sig.	Partial Eta Squared
Corrected Model	15.623[a]	2	7.811	1.440	.247	.057
Intercept	3913.373	1	3913.373	721.640	.000	.938
Achpretest	9.164	1	9.164	1.690	.200	.034
Gender	3.131	1	3.131	.577	.451	.012
Error	260.299	48	5.423			
Total	62891.000	51				
Corrected Total	275.922	50				

a. R Squared = .057 (Adjusted R Squared = .017)

Result in table 11 Shows that the P-value is$F_{(1, 48)}$ =0.577 and P=0.451>0.05 while (partial Eta squared=0.012).Since the P-value is greater than the α-value the null hypothesis was therefore accepted. Thus there is no significant different between the academic achievement of male and female students taught Basic Science using Problem-Based Learning Strategy

Hypothesis Six

There is no significant difference in the mean cognitive load scores of male and female Upper Basic 2 students taught Basic Science using Problem Based Learning Strategy.

Table 12: Analysis of cognitive load scores to covariance boys and girls taught basic science using Problem Based Learning Strategy

Source	Type III Sum of squares	df	Mean square	F	Sig.	Partial Eta Squared
Corrected Model	.877[a]	2	.438	2.485	.094	.094
Intercept	9.053	1	9.053	51.315	.000	.517
Precles	.842	1	.842	4.772	.034	.090
Gender	.064	1	.064	.361	.551	.007
Error	8.468	48	.176			
Total	258.390	51				
Corrected Total	9.345	50				

a. R Squared = .094 (Adjusted R Squared = .056)

Result in table 12 Shows that the P-value is $F_{(1, 48)}$ =0.361 and P= 0.551>0.05 while (partial Eta squared=0.07).Since the P-value is greater than α-value the null hypothesis was therefore accepted. Thus there is no significant different between the academic cognitive load of male and female students taught Basic Science using Problem-Based Learning Strategy.

Discussion of Findings

Effect of Problem-Based Learning Strategy on Student Interest in Basic Science

Result of the study in table 1 shows that students in the experimental group who were taught basic science using PBLS recorded high improvement in their interest as compared to their counterpart in the control group taught using lecture method. Also in table 7, the study revealed that the interest of students taught basic science using PBLS differ significantly from those taught using lecture method. This shows that the use of PBLS in teaching basic science can improve student's interest. This finding corroborate with Omega (2017) who in his finding shows that PBLS approach sustained student interest more than lecture method. It was also equally found that female student slightly improved in their mean interest than their male counterpart taught during the period of the study. The finding also corroborate with Itodo (2019) [35] finding which shows that PBLS enhanced student interest to learn Biology more than the lecture method. The result in the table 4 shows that female students in the experimental group had high interest slightly better than the male counterpart when taught basic science using PBLS. Furthermore, in table 9, the result indicted that there is no significant different between the interest of male and female students taught basic science using PBLS. This shows that PBLS is gender friendly and has help to close the gap seem to exist in the interest of students base on gender.

Effect of Problem-Based Learning Strategy on Students Achievement in Basic Science

Table 8 shows ANCOVA report on the effect of PBLS on students' achievement in basic science. The result revealed that P<0.05 which is indicative of a significance difference between the PBLS and the Lecture Method. With this findings, the null hypotheses which states that there is no significance difference between the mean achievement scores of basic science student taught using PBLS and those taught using Lecture Method was not accepted. The study concluded that student taught basic science using PBLS significantly achieved higher achievement score than those taught Lecture Method. Table 2 also revealed the differences in the mean achievement score of student in the PBLS group had a higher mean gain compared to those of their colleagues in the lecture method. The finding has revealed the efficacy of the use of PBLS in enhancing student achievement in basic science.

The study also sought to find out the difference in mean achievement score of male and female students taught basic science using PBLS and those taught using lecture method. Table 5 shows the mean achievement score and standard deviation of male and female students taught basic science using PBLS. The table revealed that the difference in the mean gain achievement scores of male and female students Post-Test was higher in favour of the male, however, contrary to this view in table 5. Table 11 shows ANCOVA report on the effect of PBLS on students achievement in basic science based on gender. This result shows that P>0.5 and indicative of the fact that there exist no significant different in the mean achievement scores of male and female students in PBLS group. The null hypothesis that there is no significant difference in the mean achievement scores of male and female student taught basic science using PBLS was not rejected. The conclusion of the study was that male and female taught basic science using PBLS equally benefited from the strategy. The findings of the present study corroborated with the study of Oludipe & Olupide (2010) [48], Omega (2017). These studies attested that student taught Basic Science with PBLS students perform better than the lecture method. However, the result revealed that male students in the PBLS group were significantly better than the female counterpart in the group.

Effect of Problem-Based Learning Strategy on Students Cognitive Load in Basic Science

Table 9 revealed that there is a significance difference in the mean cognitive load of students taught basic science using PBLS and those who were taught using lecture method. These therefore indicate that the PBLS is capable of reducing student's cognitive load in basic science. This means that, the efficiency of the use of PBLS in the experimental group leads to high achievement with less cognitive load.

This result agreed with Takir (2011) [67] who found that the use of instructional method affected the 7th grade student's achievement on Algebra Achievement Test and Cognitive Load. That is there was a significant difference between the students in the experimental group and those students in the control group. The result also agreed with Agbidye (2017) [5] who found that instructional design can reduce cognitive load in learners. The result agrees with Agbidye (2017) [5] that the capacity of the working memory is limited and overloaded this limit as it is the case with the lecture method were the teacher bombards the learner with a lot of information at a time without minding weather the information is too much or not. This undermines the learning process thereby constituting cognitive load and reduction in interest and achievement rate of students.

Table 12revealed that the mean cognitive load of male and female students who were taught basic science using PBLS were statistically insignificant. The study also revealed that male and female students have similar mean score of their cognitive load rating scores when taught basic science using PBLS. The mean difference was statistically found to be insignificant. These implied that the male and the female student were given equal opportunity during treatment; they expanded almost equal mental effort during learning. Thus, PBLS is an efficient strategy for basic science learning at the Upper Basic Science Level. This shows that gender is not a significant factor in the amount of mental effort expanded to understand the concept taught using PBLS. The most important factor which has significant effect on students cognitive load in basic science was the instructional strategy adopted. The study conforms With (Agbidye, 2017) [5], were he emphasized on the need to apply sound instructional design principals based on the knowledge of the brain and memory.

Conclusion

Based on the findings of the study it can be concluded in this study that the use of PBLS enhances students' interest, achievement and reduces student's cognitive load in basic science than the use of lecture method of teaching.

Recommendation

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

1. Basic science teacher should be train by Ministry of Education on the use of PBLS.
2. Ministry of Education should organize Seminars and workshops for basic science teachers in elementary and secondary schools to use PBLS in the classroom.
3. Basic science curriculum developers should make provision for the emphases on the use of PBLS by the curriculum implementers (teachers) because this method has enhanced student's interest, achievement and lowered their cognitive load in basic science.
4. Authors of basic science textbooks should include activities that will encourage the use of PBLS by the teachers and students.
5. Basic science teachers should endeavor to give female and male students equal opportunities in the classroom. Teachers of basic science are advice to adopt PBLS as it enhanced male and female students interest, achievement and reduction in cognitive load in basic science. In the use of PBLS both male and female are capable of competing and collaborating in classroom activities.

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