



Effect of Problem-Based Learning on Academic Performance in Genetics Among Senior Secondary School Students in Bauchi State

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Abstract

This study investigated the effect of problem-based learning on students' academic performance in genetics among secondary school students in Bauchi state. The study adopted quasi-experimental non-randomized pre-test posttest control group. The population consisted of 3,328, with sample size of 120 students (62 male and 58 female). Purposive sampling was used to select two co-educational schools in Bauchi state. Two intact classes from two co-educational schools were randomly selected and assigned as experimental and control groups. Both were pre-tested before the treatment and post tested after treatment. Genetic Performance Test (GPT) with reliability coefficient of $r = 0.85$ and Self-directed Learning Scale (SDLS) with reliability coefficient $r = 0.78$ were used for data collection. Analysis of covariance (ANCOVA) and t-test were used for analyzing the data collected at 0.05 level of significance. The study found that students taught using problem-based learning performed better than those taught using traditional method. The same result was obtained in their performance and self-directedness in learning. The study recommended that Biology teachers should adopt the use of problem-based learning to improve students performance in genetics.

Keywords: Gender; Genetics; Performance; Problem-based learning; Traditional method of teaching;

Introduction

Biology is one of the core science subjects that cross all fields of human life. It has application in medicine, agriculture, horticulture, biotechnology like Genetic engineering. It is one of the requirements for admission into science-based courses at tertiary institutions in Nigeria. Despite the importance of biology to human life; there are studies that indicate concern about student's poor performance in biology (Ajaja, 2012; Mahmud,

2017). WAEC head of national office, Mr. Adenipekun said that out of 1,572,396 candidates that sat for 2018 Biology and other subjects examination, only 786,016 (49.98%) had credit pass and above. Adenipekun further stressed that the performance, when compared to what obtained in the same examination in 2016 and 2017 showed a decline. The table below shows the performance of Biology students in WASSCE for the past five years

Table 1: Performance of Biology Student in WASSCE For the Past Five Year

Year	Total No. of Students That Sat	Biology Credit Passed	Percentage (%) Passed
2016	1,087,921	671,029	61.68%
2017	1,084,214	634,915	58.56%
2018	1,087,884	596,378	54.82%

2019	1,086,449	550,069	50.63%
2020	1,083,564	539,398	49.78%

The analysis of West African Examination council (WAEC) Result from 2007 to 2016 shows students poor performance in biology and other science subjects (Badmus & Omosewu, 2018). The observed decline in students' performance in SSCE biology may have a link with their perceived difficulties in understanding certain areas of biology such as Genetics which are regarded as complex or abstract. For this reason students dislike such topics and avoid them during examination (Mahmood, 2017). Among the biology topics where teachers find difficult in teaching and students find difficult in learning are Genetics, basic ecology, Evolution, Energy transfer and Hormonal Coordination (Mahmood, 2017).

In order to address these issues raised, systematic ways of teaching and learning which promote problem solving could help improve students performance and comprehension of Biological concepts (Nnamdi & Okechukwu, 2006). Problem-Based Learning (PBL) is a student centered approach in which students learn about a subject/topic by working in small groups to solve an open-ended or ill-structured problem. The problem is what drives self-directed learning and motivates students to learn (Nilson, 2010). Hmelo-silver stated that the most important factor of PBL is the problem itself. Nilson also further stressed that a well-designed PBL provides students opportunity to develop skills related to; self-directed learning, working in team, oral and written communication, working independently, critical thinking and analysis, organization and interpretation of information. The way of obtaining and using information have changed in recent years as it become accessible from multiple sources and this also challenged the belief that information is unchangeable (Ilkay & Melek, 2018). In this view, learning as memorizing information (rote learning) has faded and gave way to a problem-oriented view based on knowing and

understanding (Aspin & Chapman, 2001). Aspin and Chapman (2001) further see rote learning as conceiving the nature of knowledge as learning has changed, and learning how to learn, gained ground. An individual who learned how to learn can organize this learning, transfer new information to larger contexts, overcome difficulties and possess self confidence (Hofmann, 2008).

Biology is a compulsory subject offered by every student at senior secondary school irrespective of their sex, yet performance is low. Caleb (2015) viewed gender as an integral part of socialization process and development of the adult male and female personalities. Igbaji (2016) indicated that girls are more interested and performs better in Biology while Longe and Adedeji (2010) and Egilitodo (2019) found that science and technology is a male-dominated and females tend to shy away from them. There is inconsistency based on the review of gender. This study seeks to investigate the effects of gender on students academic performance when taught genetics using Problem-Based Learning.

Many researches compared PBL students to traditionally instructed students in different parts of the world, the results revealed positive gain in favour of PBL students than their counterpart exposed to traditional method of teaching (Bedemo, 2020; Egilitodo, 2019; Mahmood, 2017). Learning needs to be conceived of as something a learner does, not something that is done to learner (Fosnot, 1989). Thus, there is a need for a shift from a teacher centered approach to a student centered approach. In PBL environment, students are exposed to ill-structured problems (problems that do not have single solution), while dealing with such ill-structured and open-ended problem, students are able to construct their knowledge. Ill-structured problem poses multiple solutions and requires learners personal opinions. The problem requires

students to think, reason and make personal decisions based on prior knowledge and experience. When students are presented with problem in PBL classroom, they first determine what they know and generate possible hypothesis to solve the problem, decide what they need to know, locate the resources so as to reach solution to the problem and share their ideas and information with their peer groups to get conclusion for the best solution, at last, summarized the finding (process) and present the solution. Teachers are only facilitators in PBL environment who help and guide students to locate resources, keeping them on right track, at the same time challenging the learning process. Therefore, students are active learners and problem solvers and teachers are the guides.

Research Questions

1. What is the effect of PBL on students academic performance in Genetics
2. What is the difference between male and female students performance in genetics when taught using PBL?

Hypothesis

The following formulated hypotheses were for tested at 0.05 level of significance.

1. There is no significant difference between the mean performance score of students taught genetics using PBL and those that taught using traditional method.
2. There is no significant difference between the performance of male and female students taught genetics using problem based

learning (PBL).

Methodology

The research design adopted for this was quasi-experimental non-randomized pretest, posttest, control group. The study area is Bauchi Metropolis. The population of the study comprises of 3,328 SS II students in the study area. A sample of 120 students were selected using multistage sampling. Stratified sampling, purposive sampling and simple random sampling were used in the first, second and third stage respectively of the sampling procedure. The sample consisted of 56 students (30 males and 26 females) in the control group (CG) and 64 students (34 males and 30 females) in the experimental group (EG). One instrument was used for data collection namely; Genetics Performance Test (GPT). Two experts validated the instrument. The reliability co-efficient value using Kuder Recharadson formula 21 was computed to be .85 for GPT. The researcher enlisted biology teachers from the selected schools to participate in the study. The GPT instrument was administered to the students in both CG and EG to test the equity of their ability levels followed by a treatment period of 6 weeks with CG students taught using traditional method and EG students taught using PBL. At the end of the treatment period GPT was administered to the students in the two groups to see the effectiveness of the treatment. The research questions were answered using mean and standard deviation while the null hypotheses were tested using ANCOVA and t-test at .05 level of significance, via SPSS version 20.0.

Results

Table 2: Mean and Standard Deviation of Pretest and Posttest Scores of Students Taught Genetics using PBL and those Taught using TMT.

Group	N	Pre GPT mean score		Post GPT mean score		Mean diff
		Mean	Std Deviation	Mean	Std Deviation	
PBL	64	35.97	12.921	64.98	13.698	29.01
TMT	56	36.43	13.746	53.18	12.468	16.75

Table 2 shows that the group taught genetics using PBL had a pretest mean of 35.97 with standard

deviation of 12.921 and a posttest mean of 64.98 with standard deviation of 13.698. The mean gain of PBL group was 29.01 (i.e. difference between pretest mean and posttest mean of PBL). The group taught genetics using TMT has a pretest mean of 36.43 with standard deviation of 13.746 and a posttest mean of

53.18 with standard deviation of 12.468. The mean gain of TMT was 16.75.

The difference between mean gain of PBL and TMT was 12.26 in favor of PBL. This indicated that PBL may have some effect on students performance.

Table 3: Mean and Standard Deviation of Pretest and Posttest Scores of Male and Female Students Taught Genetics using PBL.

Gender	N	Pre GPT mean score		Post GPT mean score		Mean diff
		Mean	Std Deviation	Mean	Std Deviation	
Male	34	35.26	13.336	64.85	12.969	29.59
Female	30	35.17	12.868	65.13	14.703	29.96

Table 3 shows that influence of gender on students performance in genetics when taught using PBL. The table reveals that male had a pretest mean of 35.26 with standard deviation of 13.336 and a posttest mean of 64.85 with standard deviation of 12.969. The mean gain of male students was 29.59. The female students had a pretest mean of 35.17

with standard deviation of 12.868 and a posttest mean of 65.13 with standard deviation of 14.703. The mean gain of female students was 29.96. The difference between the mean gain of male and female was 0.37 in favor of female students. This shows that gender may have some effect on students performance in genetics when taught using PBL.

Table 4: Analysis of covariance (ANCOVA) of significant difference between the mean performance scores of students taught genetics using PBL and those taught using TMT.

Tests of Between-Subjects Effects
 Dependent Variable: GPTposttest

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4162.726 ^a	1	4162.726	24.113	.000	.170
Intercept	417012.793	1	417012.793	2415.543	.000	.953
Group	4162.726	1	4162.726	24.113	.000	.170
Error	20371.199	118	172.637			
Total	449007.000	120				
Corrected Total	24533.925	119				

a. R Squared = .170 (Adjusted R Squared = .163)

Table 4 shows ANCOVA report on the effect of PBL on students performance in genetics. The table reveals that F-ratio =24.113 and P = 0.00. This result reveals that associated probability value (p) = 0.00 was less than 0.05 set as level of significance. This

indicated that there exists a difference between the PBL and TMT groups. The null hypotheses which states that there is no significant difference between the mean performance scores of students taught genetics using PBL and those taught using TMT was

rejected.

Thus inference drawn therefore is that there was a significant difference in the mean performance scores of students taught genetics using PBL and those taught using TMT with those taught using PBL having a higher mean gain. The study concluded that students taught genetics using PBL significantly

achieved higher performance scores than those taught via traditional method of teaching. The partial eta squared value for group was shown as 0.17 which indicates that 17% in the mean performance scores variance of students in the two groups was attributed to PBL.

Table 5: Independent sample t-test result of the posttest GPT scores of male and female students taught genetics using PBL.

	Levenes Test for Equality of Variances		t-test for Equality of Means					
	N	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std Error Difference
Male	34	1.716	.195	.062	62	.951	.214	3.469
Female	30							

The table reveals that p-value is 0.195 which is greater than the acceptable alpha level of 0.05. This indicates that the difference in the GPT posttest mean scores of male and female students taught genetics using PBL was statistically not significant. This shows that PBL leads to higher performance of both male and female students in genetics. The null hypotheses which states that there is no significant difference between the performance of male and female students taught genetics using PBL was not rejected.

Discussion

The ANCOVA analysis examining the impact of Problem-Based Learning (PBL) on students' academic performance in genetics revealed a significant difference between the PBL and Traditional Method of Teaching (TMT) groups (F-ratio = 24.113, P = 0.00). The null hypothesis suggesting no significant disparity in mean performance scores between the two teaching methods was rejected, indicating that students taught genetics through PBL achieved notably higher scores compared to those instructed via the traditional method. Table 2 further illustrates that the PBL group exhibited a higher mean gain in

performance scores compared to the traditional group, reinforcing the substantial effect of PBL in enhancing students' genetic learning outcomes.

Additionally, the study aimed to explore gender-based differences in mean performance scores among students taught genetics using PBL. Table 3 presented the mean performance scores and standard deviations of male and female students exposed to PBL, demonstrating that female students displayed a higher mean gain than their male counterparts. However, the t-test report in Table 5 indicated that there was no significant difference in the mean performance scores between male and female students within the PBL group. Consequently, while the study rejected the null hypothesis positing no difference in mean performance scores based on gender in PBL, it concluded that female students benefited more than males when taught genetics through PBL. This aligns with previous studies by Mahmood (2017), Egilitodo (2019), and Bedemo (2020), which similarly supported PBL's effectiveness over traditional teaching methods in enhancing student performance. However, this finding contrasts with the views of Longe and Adedeji (2010) and Egilitodo (2019), suggesting that science and technology fields are male-dominated, a

perspective not upheld by the present study.

The efficacy of Problem-Based Learning (PBL) in genetics education is attributed to its logical and sequential instructional approach, fostering practical skills and facilitating a deeper and more organized comprehension of the subject matter. Exposure to PBL equips students with comprehensive knowledge and enhances their ability to structure thoughts systematically, essential for effective problem-solving skills.

Conclusion and Recommendations

This study investigated the effect of PBL on academic performance in genetics among senior secondary school SS II students and found that PBL significantly enhanced the performance of students better than the traditional method. It was found that PBL was gender insensitive and therefore the method is applicable to both male and female students. We advocate that the findings of this study can be generalized or replicated in other parts of country for smooth integration into the national curriculum. Based on the findings of this study the following were recommended:

1. Teachers may find the study useful in their effort to improve students academic performance and retention in biology. It is suggesting that teachers should endeavor to hold PBL with students regularly to expose them with different learning sources.
2. Professional bodies such as Nigeria Educational Research Development Council (NERDC), Science Teachers Association of Nigeria (STAN) should organize workshop on the use of constructivist teaching method such as PBL.

References

Ajaja, P. O. & Urhievweji, O. E. (2012). Effects of 5E learning cycle on students achievement in biology and chemistry. *Cypriot Journal of Educational Sciences*, 7(3), 244-262.

Badmus T. O. and Omosewu, O. E. (2018). Improving science education in Nigeria. The

role of key stake holder, *European Journal of Health and Biology Education*, 2018 7(?) em ??
ISSN: 2165-8722
<http://doi.org/10.2933/ejhbe/xxxxx>

Bedemo, S. (2020). Effects of Problem Based Learning on Students Achievement and Attitude Towards Physics (Mechanics): The Case of Gilgel Beles College of Teachers Education. *Science Journal of Education*. 8(3): 71-81. doi: 10.11648/j.sjedu.20200803.12

Egilitodo, E. (2019). Effects of problem-based learning strategy on Senior secondary school students interest, achievement And retention in biology in taraba state, Nigeria. (Unpublished PhD Thesis,) Department of curriculum and teaching, faculty of education, University of Agriculture, Makurdi, Benue State.

Fosnot, C. T. (1989). *Enquiring Teachers Enquiring Learners: A constructivist approach for teaching*. New York : Teachers College Press.

Mahmood. A. (2017). *Impact of problem solving and discovery strategies on attitude, retention and performance in Genetics concept among secondary school student in Zaria*. An Unpublished Ph.D thesis. Department of science education, faculty of education Ahmadu Bello University Zaira.

Nnamdi, S. O and Okechukwu, R. (2006). The Effect of Concept Mapping and Problem-Solving Teaching Strategies on Achievement in Genetics among Nigerian Secondary School Students. *African Journal of Educational Studies in Mathematics and Sciences* Vol. 4, 2006.

W.A.E.C (2015-2020) West African Examination Council, Biology Chief Examiner's Report. Lagos; WAEC.

West African Examination Council (2010). Senior secondary Certificate examination, Yaba Lagos Nigeria. Examiner report.

West African Examination Council (2011). Senior Secondary Certificate Examination. Webster, M. [web-dictionary@ psycob.com](http://web-dictionary@psycob.com) Retrieval jan.11th (2010).



- Caleb, I (2015). Effects of problem-solving and discussion teaching methods on students achievement in genetics. An Unpublished M.Ed thesis. Department of science education, faculty of education University of Nigeria, NSUKKA
- Igbaji, C. (2016). Factors affecting students attitude and interest in Biology secondary schools in Izzi local government area of Ebonyi state. (Unpublished Ph. D thesis) Ebonyi State University, Abakiliki.