International Journal of
Science, Architecture, Technology and Environment

Effect of Project-Based Learning on the Achievement of Students in Basic Science at Secondary Schools in Kebbi State, Nigeria

Usman Gado Birnin Tudu[1*]

[1]*Department of Science Education, Adamu Augie College of Education, Argungu, Kebbi State, Nigeria*

[*]*Corresponding author, gbirnintudu@gmail.com*

DOI: https://doi.org/10.63680/ijsate092615.24

Abstract

There is a need for a change from teacher-centered approaches to more learner-centered methods that are designed to improve learners' engagement and learning involvement. The current study compared Project-based Learning (PjBL) with Conventional Learning Method (CLM) to determine its effectiveness on student's achievement in Basic Science subject. Quasi-experimental non-equivalent control groups research design was employed. Purposive sampling was used in composing two intact classes. A sample of 80 students distributed across experimental (40) and control (40) groups in two public secondary schools located in Kebbi, Nigeria is used. Descriptive statistics and the sample t-test were used to examine the variables. Data for this study were generated through pre-test, post-test, and delayed post-test. The results revealed a significant difference in the student's achievement in Basic Science in favor of the experimental group who experienced PjBL with a large effect size. However, there is no striking effect among students who experienced PjBL environment on retention of achievement in Basic Science.

Keywords: Project-Based Learning, Conventional Learning Method, Achievement

INTRODUCTION

Globally scientific and technological advancement of any society relies on its Science Education. A developing country like Nigeria, is aware of the critical roles science education played in the social and economic development (Akpokiniovo & Odebala, 2015). Basic Science and Technology was adopted in Nigeria as compulsory courses for the basic educational level to provide foundation for science and technology (Ozoji, 2020). The basic science is taught such that the student obtains the conception of the fundamental unity of science, the importance and function of science in daily life (FRN, 2013). The National Policy on Education therefore, recommended the adoption of student-centered approach in teaching and learning of Basic Science courses (Federal Republic of Nigeria, 2013).

In spite of all the efforts made by the government of Nigeria to promote enrolment in science subject and improvement in science teaching and learning among students at basic educational levels, the number of students enrolled in core science subjects and science-oriented courses at the senior secondary school level

and tertiary institutions is low (Usman, 2025). Most of the concepts in Basic Science like state of matter which is among the foundational topics of basic science and which require students to understand the assumptions of the kinetic theory of matter, the molecular structure of solids, liquids and gasses were perceived difficult and misconceived by majority of students (Abubakar, 2024). As pointed out by Obianuju, (2013), inappropriate approaches of instruction have contributed greatly to the difficulties. In light of these challenges, more researches are needed to determine effective and suitable approaches in improving science teaching and learning (Libata, 2023).

OBJECTIVES OF THE STUDY

1. To examine the effectiveness of PjBL and CLM on the achievement of Junior Secondary School students in Basic Science.
2. To determine the effectiveness of PjBL and CLM on the retention of Junior Secondary School students in Basic Science.

RESEARCH QUESTIONS

1. Is there any difference between the effect of PjBL and CLM on Junior Secondary School students' achievement in Basic Science?
2. Is there any difference between the effect PjBL and CLM on the retention of Junior Secondary School students' achievement in Basic Science?

RESEARCH HYPOTHESIS

1. There is no significant difference between the Scores of Post Test and Delayed Post Test of Students exposed to Project-Based Learning.

REVIEW OF RELATED LITERATURE

Basic Science Education in Nigeria

Science is a structured framework of knowledge and complex activity that leads to the universal body of knowledge called laws, hypotheses, and theories explaining the natural prodigies (Chalmers (2013). It is a subject that has an impact on our everyday activities. On the other hand, Wasagu (2009), described Basic Science education as an integral area of study that addresses science disciplines, i.e. (biology, chemistry, and physics). Subsequently, science teachers' roles are to guide individuals to discover how facts are known and how these facts can be built from fragments of data into a structural form of knowledge.

Basic science is one of the compulsory subjects for junior secondary education in Nigeria. Basic science teaching is integrated, comprising biology, chemistry, and physics topics (Bukunola & Idowu, 2012). This ensures individuals acquire scientific knowledge and develop scientific skills. The role of science in the development of a nation can never be emphasized. In Nigeria today, the junior secondary level of education is both academic and pre-vocational. It is now compulsory in all the federation; the aim is for all citizens to have access to basic education (FRN, 2013).

Science has critical role to play for national development. As such, the Federal Government of Nigeria in the National Policy on Education gave a special place to science, technology, and mathematics education and the

promotion of scientific literacy to her citizenry (FGN, 2013). This is because, Basic Science should enable students to be able to: carefully and thoroughly observe, report accurately, organize data, make a generalization based on acquired data, raise hypotheses, design experiments, use models to clarify phenomena and proceed the process of inquiring when new information does not conform to predictions (STAN, 1970). These objectives can be achieved if student-centered approaches like PjBL, are employed in teaching and learning of Basic Science courses.

Misconceptions on Basic Science Concepts Among Basic Science Students

Although the Basic Science Courses are regarded as simple and well-known topics, there is an increasing number of student's and teacher's misconceptions on some concepts like the concept of state of Matter (Tatar, 2011). A lacks of complete ideas about this concept may have a detrimental effect on the scientific understanding of the other concepts in the subsequent learning of science. More studies on how to reduce such misconceptions should be conducted (Laliyo, Tangio, Sumintono, Jahja, and Panigoro, 2020). Hanson, (2020), argued that because of lingering misconceptions students hold, coupled with the low academic achievement which invariably leads to loss of interest in studying science, teachers should select and adopt an instructional approach that looks into prior information of students, provides hands on and mind on activities and support science teachers in the dissemination of knowledge through inquiry activities.

A study conducted by Griffiths and Preston (1992, Abubakar, 2024) reports that almost 50% of 18-year students think water molecules in steam are more extensive than those in ice. Among the most common misconception individual have is the belief that gas is not a substance and has no weight or mass. Students believe that when a substance expands or contracts, such as water expanding when it freezes to form ice, the volume of the individual molecules changes instead of the space between them (Yezierski & Birk, 2006). Students' inability to comprehend electrostatic forces between particles leads to misconceptions (Talanquer, 2009).

METHODOLOGY

Quasi-experimental design was employed. Specifically, this study utilized a non-equivalent control and experimental group, pre-test, post-test, and delayed post-test design to investigate the effect of independent variables on the dependent variable. Basic Science Achievement Test (BSAT) was developed by the researcher to gather data from pre, post, and delayed posttest. A four-day workshop was organized by the researcher for research assistants on how to implement the current approach.

A pretest was conducted to find out the knowledge level of students on the Basic Science Concepts. This was followed by intervention which lasted for six weeks. immediately after the intervention, post test was conducted. Two weeks later a delayed post test was conducted to find out the retention level of the students exposed to Project-Based Learning environment.

Two public secondary schools were selected randomly in which purposive sampling was employed in assigning participants into intact classes of experimental and control group. The 80 sample of JSSII students were divided into two groups. The first experimental group (n=40) received instruction using the PjBL, whereas the second group i.e. the control group (n=40) received support using a CLM. Finally, for data analysis, IBM SPSS version 26 was used. Descriptive statistical techniques were employed to find the mean and standard deviation for the pre-tests, post-tests and delayed posttest of the SMAT. To test the hypothesis an independent samples t-test was used.

RESULTS

Table 1

Mean Scores of Students on BSAT for Pre-Test and Post-Test

		Pre-test		Post-test		
Group	N	Mean	Std. Dev.	Mean	Std. Dev.	Mean difference
Control	40	9.50	4.624	10.63	4.705	1.13
Experimental	40	10.25	4.960	16.90	3.470	6.65
Mean difference		0.75		6.27		

Before the intervention as shown in Table 1, the two groups had no major difference in their achievement. The mean difference was 0.75. After the intervention in which the experimental group were taught with the PjBL, the mean difference rose to 6.27. The mean score of students in the control group did not differ much between the pre-test and post-test. The mean difference was 1.13. The mean score of students in the experimental group increased from 10.25 to 16.90 with a mean difference of 6.65. Project-Based Learning therefore, had a major positive impact on the achievement of students in Basic Science.

TABLE 2

Mean Scores of Students on BSAT for Post-Test and Delayed Post Test

		Post-score means		Delay score Means		Mean difference
Group	N	Mean	Std. Dev.	Mean	Std. Dev.	
Control	40	10.63	4.705	13.18	5.144	2.55
Experimental	40	16.90	3.470	16.80	3.065	0.10
Mean difference		6.27		3.62		

Looking at the table 2, lower mean retention score on the Basic Science Achievement Test was experienced on the control group students compared with their counterpart, the experimental group. The control group had a mean achievement of 10.63 while the experimental group had a mean score of 16.90. The mean difference was 6.27. At the delayed test (retention) test level the mean achievement of the control group rose to 13.18 with a standard deviation of 5.144 and increased mean difference of 2.55. For the experimental group, mean achievement was 16.80 with a standard deviation of 3.065. The mean difference was 0.10. At the retention test level, the improvement in the Basic Science Achievement Test by students in the experimental group did not reduce much which showed that the application of PjBL had positive effect on retention of achievement in Basic Science.

Table 3

Two Sample T-Test on Post and Delay Post-Test of BSAT for Students Exposed to PjBL Learning

Stage	N	Mean	Std. Dev.	Std. Error	t-value	df	p-value
Post-test	40	16.90	3.470	0.549	0.064	78	0.942
Delayed-test	40	16.80	3.065	0.485			

(t-critical =2.00, $p < 0.05$)

Result in Table 3 revealed that mean post-test achievement of the students exposed to the use of the PjBL did not differ significantly from the mean score at the delayed post-test level. The observed t-value was 0.064 with a p-value of 0.942 ($p > 0.05$). These observations did not provide sufficient evidence for rejecting the

hypothesis. The hypothesis that there is no significant difference between the Scores of Post Test and Delayed Post Test of Students exposed to PjBL is therefore retained.

DISCUSSION

The current study revealed that, PjBL significantly improved mean achievement of students in learning Basic Science when compared with students in the conventional learning method. The study found that performance of the students was significantly higher after the intervention than was obtained before the intervention. The observed difference was found to be significant. The finding here is in line with Abubakar, (2025); Usman, (2024)) who reported that project-based learning is capable of engaging in hands-on activities which enhance students to obtain high performance.

The two groups had no major difference in their achievement before the intervention. The mean difference was 0.75. According to Table 2, after the intervention, the results of the post-test on students' performance in Basic science shows that students who received instruction using the PjBL had higher mean scores than students who received treatment using Conventional Learning Method, with lower mean scores. This finding is consistent with Gezim & Xhomar, (2020); Fitriani, et al., (2020), and Sunyoung, et al., (2016) findings that students perform better academically when taught utilizing the PjBL than those taught with CLM. The study's findings were actually supported by the report of Atusumbe, (2019); and Bahar, et al., (2020); which stated that student-centered approaches are effective technique for promoting students' achievement.

The result supports the research by Bukunola, & Idowu, (2012) and Fitriani, et al., (2020), who looked at the impact of the CLM techniques on secondary school students' performance in science. Their findings demonstrated that the CLM group outperformed the traditional teaching method group by a large margin. Additionally, the present study is in line with Blancia & Fetalvero, (2021), who reported that when science concepts were taught via the CLM, students have positive understanding and performed better. When compared to conventional methods of instruction, the study found that students in the CLM class had a better conceptual knowledge of the concepts of diffusion and osmosis.

The post-test results supported Fitriani et al., (2020) and Bukunola, & Idowu, (2012), claim that Constructivists approaches have a positive influence on students' achievement, and Aidoo, Boateng, Kissi & Ofori, (2016) who maintained that PjBL is a powerful strategy for enhancing learning outcome. Mean post-test achievement of the students exposed to use of the PjBL did not differ significantly from the mean score at the delayed post-test level. The observed t-value was 0.064 with a p-value of 0.942 ($p > 0.05$). This was an indication that, students taught with PjBL can retained information learned. The study therefore is still in support of Atusumbe (2019), who stated that compared to conventional methods of instruction, the student-centred approach boost student's performance and retentive capacity. The current research is also in line with the findings of Ameen, et al., (2022) who claimed that use of PjBL in classroom instructions helps students to retain information and perform better in their examinations. Conventional methods of instruction have been found by this study to have negative effect in learning basic science. This supported the findings of Usman, et al., (2023), that effective learning is minimal through conventional learning process.

CONCLUSION AND IMPLICATIONS

Based on the results of the current study, it can be concluded that the PjBL approach greatly outperforms the conventional teacher-centred method in terms of student achievement. The application of PjBL would be an effective learning technique that may be utilized to help students overcome misconceptions issues. This would

undoubtedly address the long-standing issue of low success caused by student incapacity to recollect facts when needed.

A wide range of implications for students, teachers, curriculum planners, states and federal ministry of education and educators were obtained. The results indicated that providing equity in classroom ensure equality of outcome across students irrespective of their learning difference. There is evidence that teaching a content course using instructional material prepared based on PjBL can support students to learn actively and improve students' learning. The study has also provided a better understanding of the constructivism school of thought on teaching and learning.

There is also the need for the teachers to consider and determine student's possible misconceptions before teaching delivery so as to make use of the information obtained in selecting appropriate approach in promoting concrete and meaningful learning and to avoid the building up more misconceptions. In addition, teachers need to be mindful of the difficulties faced by students when learning the concepts. Teachers should be aware that students need only guidance by providing them with all the necessary materials and procedures to build their own knowledge.

Declaration of Conflicting Interests

The authors declare no potential conflicts of interest with respect to the research, authorship and publication of this article.

Funding

The author received no financial support for the research, authorship and publication of this article.

References

Akpokiniovo, S. R., & Odebala, E. (2015). Implementing the Universal Basic Science Education Curriculum for Development in Nigeria beyond 2020. Multi-Disciplinary Journal of Academic Excellence, 13(1), 56-67.

Alamina, J. I., & Etokeren, I. S. (2018). Effectiveness of Imagination Stretch Teaching Strategy in Correcting Misconceptions of Students about Particulate Nature of Matter. Journal of Education, Society and Behavioural Science, 27(1), 1-11.

Atsumbe, B. N. (2019). Refocusing Science, Technology, Engineering and Mathematics (STEM) education in Nigeria for societal needs. Kontagora Journal of Science and Technology, 4(1), 1–12.

Bahar, M., & Aksut, P. (2020). Investigation on the effects of activity-based science teaching practices in the acquisition of problem-solving skills for 5–6-year-old pre-school children. Journal of Turkish Science Education, 17(1), 22-39.

Bimbola, O., & Daniel, O. I. (2010). Effect of constructivist-based teaching strategy on academic performance of students in integrated science at the junior secondary school level. Educational Research and Reviews, 5(7), 347-353.

Blyth, K. (2010). Effectiveness of Using Inquiry Based Instruction to Increase Students Performance in High School Biology as Bardwell Institute. Retrieved from.http://digitalcommons.odu.edu/cgi/viewcontent.cgi? article=1045& context=ots_masters_projects

Bukunola, B. A. J., & Idowu, O. D. (2012). Effectiveness of cooperative learning strategies on Nigerian junior secondary students' academic achievement in basic science. Journal of Education, Society and Behavioural Science, 2(3), 307-325.

Campbell, D. T., & Riecken, H. (1968). Quasi-experimental design. International encyclopedia of the social sciences, 5, 259-263.

Chalmers, A. F. (2013). What is this thing called science? Indianapolis, IN: Hackett Publishing.

Creswell, J. W. (1994). Research design: Qualitative and quantitative approaches. Thousand Oaks, 88(2), 207-215.

Creswell, J. W. (2014). A concise introduction to mixed methods research. Thousand Oaks, CA: SAGE publications.

Daniel, O. B. (2010). Effect of constructivist-based teaching strategy on academic performance of students in integrated science at the junior secondary school level. Educational Research and Reviews, 5(7), 6-15.

Emmanuel, Y. (2013). Fundamentals of Research Methodology. Kaduna, Nigeria: Sunjo A.J Global Links LTD

Federal Republic of Nigeria (2013). National Policy on Education (6th ed.). Lagos: NERDC Press.

Fitriani, A., Zubaidah, S., Susilo, H., & Al Muhdhar, M. H. I. (2020). The effects of integrated problem-based learning, predict, observe, explain on problem-solving skills and self-efficacy. Eurasian Journal of Educational Research, 20(85), 45-64.

Gorowara, S., & Lynch, R. (2019). A Comparative study of grade 6 science students' academic achievement under teacher-centered learning method and inquiry-based learning method at Panchasap. Human Sciences, 11(2), 153–164.

Hanson, R. (2020). Chemistry teachers' interpretation of some students' alternative conceptions–a pilot study. African Journal of Chemical Education, 10(1), 6996.

Idowu, D. (2011). Developing Nigerian integrated science curriculum. International Journal of Science and Technology Education Research, 2(8), 134-145.

Laliyo, L. A. R., Tangio, J. S., Sumintono, B., Jahja, M., & Panigoro, C. (2020). Analytic Approach of Response Pattern of Diagnostic Test Items in Evaluating Students' Conceptual Understanding of Characteristics of Particle of Matter. Journal of Baltic Science Education, 19(5), 824-833.

matter. Educational Research and Reviews, 6(2), 197-200.

NPE. (2013). National policy on education (6th ed.). Nigeria: Nigerian Educational Research and Development Council (NERDC).

Nasir, M., Fakhrunnisa, R., &Nastiti, L.R.2019. The Implementation of Project-based Learning and Guided Inquiry to Improve Science Process Skills and Student Cognitive Learning Outcomes. International Journal of Environmental & Science Education. Vol 15 No 5. Hal 229 – 238.

Obianuju, O. S., Obiajulu, A. N., & Ella, F. A. (2013). Science education for sustainable development in Nigeria: challenges and prospects. Academic Journal of interdisciplinary studies, 2(6), 159-159.

Okoro, S. U. (2015). Basic Science Education and Development: A Virile Vehicle for Education and Development in Nigeria Beyond 2020. Journal of Pristine. 11 (1), 206-216

Omorogbe, E., & Ewansiha, J. C. (2013). The challenge of effective science teaching in Nigerian secondary schools. Academic Journal of Interdisciplinary Studies, 2(7), 181-196.

Onwu, G. O., & Randall, E. (2006). Some aspects of students' understanding of a representational model of the particulate nature of matter in chemistry in three different countries. Chemistry Education Research and Practice, 7(4), 226239.

Osuyi, S. O. (2021). Effect of Problem-Based Teaching Method on Students' academic Performance in Basic Technology in University Demonstration Secondary Schools, Edo State, Nigeria. Sokoto Educational Review, 20(1&2), 75-85.

Othman, J., Treagust, D. F., & Chandrasegaran, A. (2008). An investigation into the relationship between students' conceptions of the particulate nature of matter and their understanding of chemical bonding. International Journal of Science Education, 30(11), 1531-1550.

Ozoji, B. E. (2020). Effects of Concept Mapping Technique on Nigerian Junior Secondary School Students' Cognitive Development and Achievement in Basic Science and Technology (Integrated Science) Science Education in the 21st Century (pp. 95-111). New York: Springer.

Samsudin, M. A., Jamali, S. M., Md Zain, A. N., & Ale Ebrahim, N. (2020). The effect of STEM project-based learning on self-efficacy among high-school physics students. Journal of Turkish Science Education, 16(1), 94-108.

Sunyoung, H. A. N., Rosli, R., Capraro, M. M., & Capraro, R. M. (2016). The effect of science, technology, engineering and mathematics (STEM) project-based learning (PBL) on students' achievement in four mathematics topics. Journal of Turkish Science Education, 13(special), 3.

Tatar, E., (2011). Prospective primary school teachers' misconceptions about states of matter. Educational research and Reviews 6(2), 197-200.

Usman, G. B., Ali, M. N. & Ahmad, Z. (2023). Effectiveness of STEM Problem-Based Learning on the Achievement of Biology among Secondary School Students in Nigeria. Journal of Turkish Science Education, 20(3), 453-467.

Wasagu, M. A. (2009). Rethinking science education for the changing times: The writing on the wall. Nigeria: Trans-akab LTD.