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Effect of Project-Based Learning Strategy on Students' Interest and Performance in Science in Calabar Municipality, Cross River State

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Abstract
This study investigated the impact of project-based learning on students' interest and academic performance in science in Calabar municipality local government area of Cross River state**.** The study adopted a pre-test, post-test quasi-experimental research design. Two research questions and hypotheses guided the study. The sample comprised 150 SSII students drawn from a population of 2100 students in the study area. The research instrument was a researcher-made test, tagged Science Achievement Test(SAT), with a reliability estimate of 0.80 using Kuder-Richardson, R-20, and a student interest questionnaire with a reliability index of 0.70 using Cronbach's alpha reliability estimate. The da\ta collected were analysed using descriptive and ANCOVA statistical tools. The result revealed that there was statistically significant difference in the student's academic achievement $F(1, 146) = 29.85$, $p < 0.000$.with a mean gain score of 52.35 and the level of interest of students on the concept taught $F(1, 147) = 2.75$, $p < 0.000$ in favour of those in PBL group with with a mean gain of 23.25. It is recommended that science teachers integrate project-based learning in the science classroom to enhance students' understanding of science concepts and stimulate interest in science.

Keywords: Project-Based Learning, Academic, Performance, Student, Interest

Introduction

Student engagement remains a core challenge in science education, particularly in science subjects that require comprehension of abstract concepts. Differentiated instruction aligned with learning styles, such as Project-Based Learning (PBL), has been shown to enhance engagement and interest (Gardner, 2021). PBL is a constructivist, student-centered approach in which learners collaborate on real-world problems through inquiry, planning, execution, and reflection (Kalyoncu & Tepecik, 2020). This method fosters communication, critical thinking, and deep learning (Bell, 2020), with teachers acting as facilitators. Empirical studies support PBL's effectiveness in improving academic achievement and student interest across various science disciplines (Omeje, 2023; Matilainen et al., 2021; Haetami et al., 2023; Al-Rawi et al., 2023). However, findings remain mixed; for instance, Eze et al., (2021) reported no significant impact of PBL on achievement and retention in technical subjects. In terms of interest, studies such as those by Suryaningsih et al., (2022), Masbukhin et al., (2023), and Dinda et al., (2024) confirm PBL's positive effect on students' interest and enthusiasm, though Jeffry et al., (2019) noted regional differences. Despite promising results, gaps persist in understanding PBL's effects in diverse educational contexts, especially within science education.

Aim and Objectives of the Study

This study aims to investigate the impact of project-based learning on students' academic achievement and interest in science within a specific local context. Specifically, the study sought to:

1. Determine the mean difference in the performance scores of students taught science using project-based learning and those taught using the conventional lecture method.
2. Determine the mean difference in the interest scores of students taught Science using project-based learning and those taught using the conventional lecture method.

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Research Questions

1. What is the mean difference in the performance scores of students taught science using project-based learning and those taught using the conventional lecture method?
2. What is the mean difference in the interest scores of students taught Science using project-based learning and those taught using the conventional lecture method?

Hypotheses

1. There is no significant difference in the mean performance scores of students taught science using project-based learning and those taught using the conventional method.
2. There is no significant difference in the mean interest scores of students taught science with a project-based learning strategy and those taught using a conventional method.

Materials and Methods

This study employed a quasi-experimental research design, which is well-suited for educational contexts where random assignment of participants to experimental and control groups may be logistically or ethically unfeasible. The quasi-experimental design allows for the comparison of outcomes across groups while preserving the ecological validity of intact classroom settings. A sample size of 150 Senior Secondary II (SSII) students was drawn from a population of 2,100 students across public secondary schools in Calabar Municipality Local Government Area. The selection was conducted using a simple random sampling technique, which enhances the representativeness and reduces selection bias. Three schools were randomly selected, and students were subsequently assigned to either the experimental or control group. This sample size was deemed adequate for the statistical techniques employed, particularly ANCOVA, providing sufficient statistical power to detect significant treatment effects while remaining manageable for instructional implementation and data collection.

Two primary instruments were utilized in the study:

1. Science Achievement Test (SAT): This instrument consisted of 25 multiple-choice items, each with four options—one correct answer and three distractors. The test was developed to assess students' knowledge of water quality and purification, the concept taught during the intervention. The pre-test was administered to determine baseline knowledge, while the post-test, which contained the same items rearranged to minimize recall bias, was used to assess learning outcomes following the instructional intervention. The SAT demonstrated good internal consistency, with a Kuder-Richardson Formula 20 (KR-20) reliability estimate of 0.80, indicating that the test items were adequately homogeneous and appropriate for measuring cognitive achievement in the targeted science content.
2. Student Interest Questionnaire: This 10-item instrument was designed using a 4-point Likert scale to assess students' interest in the subject before and after the intervention. The pre-interest questionnaire was administered concurrently with the pre-test to establish a baseline level of engagement, while the post-interest questionnaire was administered alongside the post-test to capture changes in interest. The reliability of the questionnaire was assessed using Cronbach's Alpha, yielding a reliability coefficient of 0.70, which is considered acceptable for research in educational settings.

The experimental group received instruction through a Project-Based Learning (PBL) strategy, which involved hands-on construction of water settling tanks with filter beds, providing experiential learning opportunities directly related to the science topic. In contrast, the control group received instruction through the traditional lecture method over four weeks. Following the intervention, both groups completed the SAT and interest questionnaire again. Data were analyzed using descriptive statistics to summarize students' performance and interest levels, and Analysis of Covariance (ANCOVA) was employed to control for initial differences and test for statistically significant treatment effects. The use of ANCOVA enhances the internal validity of the findings by adjusting for pre-test scores and isolating the impact of the instructional strategy on student achievement and interest. All ethical protocols were strictly observed. **Informed consent** was obtained from school authorities and participants, who were made aware of the study's purpose, procedures, and their right to withdraw at any point without penalty. Participants were assured of **confidentiality**, and data were anonymized to protect identities. The study upheld the principles of **voluntary participation, non-maleficence,** and **academic integrity** throughout its execution.

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Results

Research Question 1:

Table 1: Mean (M) and standard deviation of students' achievement scores by teaching methods

Treatment Groups	N	Pre-test		Post-test		Mean Gain Score
		M	SD	M	SD	
Control	75	12.65	3.11	45.50	2.24	32.85
Experimental	75	13.62	2.51	65.97	7.24	52.35

Source: Author's Field Data, 2025

Table 1 shows the pre-test and post-test mean scores and standard deviation of scores of students taught using PBL and a conventional strategy. The pre-test and post-test mean score differences of students in the control group are 12.65 and 45.50, while those of those in the experimental group are 13.62 and 65.97. This shows that the two groups had post-test mean scores that were higher than their pre-test mean scores. Also, the observed mean gain for the control group is 32.85, while that of the experimental group is 52.35, indicating that those in the experimental group had a higher mean gain. Whether the observed difference in the mean scores of the two groups was statistically significant was determined by the results for testing hypothesis two displayed in Table 2.

Hypothesis 1:

Table 2: Summary of Analysis of Covariance (ANCOVA) of the students' post-test scores classified by treatment groups with pre-test scores as covariate

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision at p<.05 alpha
Corrected Model	15749.901[a]	3	5249.967	181.851	.000	S
Intercept	19469.463	1	19469.463	674.394	.000	S
Pretest	1.284	1	1.284	.044	.833	NS
Treatment	387.833	1	387.833	13.434	.000	S
Error	4214.959	146	28.870			
Total	486007.000	150				
Corrected Total	19964.860	149				

a. R Squared = .789 (Adjusted R Squared =.785)

b. Computed using alpha = .05

Source: Author's Field Data, 2025

In Table 2, the calculated F-ratio for the effect of instructional strategies at (df 1, 146) is 13.43, while its corresponding calculated level of significance is .000 alpha. This level of significance is less than .05, in which the decision is based, indicating that there was a significant difference in the academic achievement mean scores of students in the concepts taught using PBL and the Conventional lecture strategy. With this observation, null hypothesis 1 was rejected.

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Research question 2

Table 3: Mean (M) and standard deviation of students' pre-interest and post-interest scores classified by treatment groups

Treatment Groups	N	Pre-interest		Post-interest		Mean Gain Score
		M	SD	M	SD	
Control	75	13.12	1.45	26.98	1.95	13.86
Experimental	75	14.04	1.45	37.29	1.29	23.25

Source: Author's Field Data, 2025

Table 3 shows the pre- and post-interest mean scores and standard deviation of scores of students taught using PBL and a conventional strategy. The pre- and post-interest scores of students in the lecture group were 13.12 and 26.98, with a mean gain of 13.86, while the pre- and post-interest scores of students in the PBL were 14.04 and 37.29, with a mean gain of 23.25. Expectedly, the two groups had post-interest mean scores that were higher than their pre-interest mean scores. Whether the observed difference in the mean scores of the two groups was statistically significant was determined by the results for testing of hypothesis one displayed in Table 4.

Hypothesis 2:

Table 4: Summary of Analysis of Covariance (ANCOVA) of the students' post-interest scores classified by treatment groups with pre-interest scores as covariate

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision at p<.05 alpha
Corrected Model	3984.775[a]	2	1992.387	722.654	.000	S
Intercept	1826.231	1	1826.231	662.388	.000	S
Pre-interest	1.248	1	1.248	.453	.502	NS
Treatment	3657.454	1	3657.454	1326.587	.000	S
Error	405.285	147	2.757			
Total	159337.000	150				
Corrected Total	4390.060	149				

a. R Squared = .908 (Adjusted R Squared = .906)

b. Computed using alpha = .05

Source: Author's Field Data, 2025

In Table 4, the calculated F-ratio for the effect of instructional strategies at (df 1, 147) is 1326.587, while its corresponding calculated level of significance is .000 alpha. This level of significance is lower than .05, at which the decision is based, indicating that there was a significant difference in the mean interest scores of students in the concepts taught using PBL and the Conventional strategy. With this observation, null hypothesis 2 was rejected.

Discussion

While this study provides valuable insights into the effectiveness of Project-Based Learning (PBL) in enhancing students' academic achievement in science, it is important to acknowledge the limitation posed by the relatively small sample size of **150 students** drawn from a population of **2,100**. Although the sample was randomly selected and stratified across three schools to enhance representativeness, a larger sample size would have provided greater statistical power, increased the generalizability of the findings, and allowed for more nuanced subgroup analyses (e.g., across schools or socio-economic backgrounds). The current sample, while adequate for detecting significant differences through ANCOVA, may not fully capture the diversity of learning contexts or student characteristics across the entire population. Future studies should therefore consider using larger, more diverse samples to validate and expand on these findings.

Despite this limitation, the study revealed a **statistically significant difference** in academic achievement between the experimental (PBL) and control (conventional lecture) groups. Students taught using PBL had a **post-test mean score of 65.97**, significantly higher than the **control group's mean of 45.50,** with a **mean gain difference** of **52.35** compared to **32.85** in the control. This underscores the pedagogical effectiveness of PBL in promoting higher learning outcomes. The improved academic achievement among students in the PBL group can be attributed to several core features of project-based learning:

1. **Active Engagement**: PBL requires students to engage with content through inquiry, exploration, and problem-solving, which promotes meaningful learning and deeper conceptual understanding.
2. **Contextualization of Learning:** By linking abstract scientific concepts to real-world applications, such as constructing a water purification system, students are more likely to perceive relevance and retain knowledge.
3. **Collaborative Learning:** The collaborative nature of PBL encourages peer interaction, dialogue, and the co-construction of knowledge, which supports both cognitive and social development.
4. **Student Autonomy and Motivation:** PBL fosters intrinsic motivation by giving students greater ownership over their learning process, encouraging creativity, and supporting diverse learning preferences.

These findings are in line with prior research (e.g., Haetami et al., 2023; Al-Rawi et al., 2023; Matilainen et al., 2021; Omeje, 2023) that has consistently shown PBL to be effective in improving academic performance, particularly in science disciplines. The interactive, experiential, and student-centered nature of PBL enables learners to construct knowledge actively rather than passively receive it, leading to improved retention and application of scientific concepts. However, contrasting evidence from studies such as Eze et al. (2021) and Kizkapan et al. (2017), which found no significant differences between PBL and conventional strategies, highlights the importance of **contextual factors** such as teacher preparedness, resource availability, and fidelity of implementation. These factors must be carefully considered when scaling or replicating PBL interventions to ensure consistent impact. While the modest sample size limits the generalizability of this study's findings, the observed learning gains in the PBL group reinforce the instructional value of project-based approaches in science education. Larger-scale studies, longitudinal investigations, and mixed-methods research are recommended to further validate these outcomes and explore the mechanisms through which PBL influences student achievement. The significant increase in students' interest in science among the Project-Based Learning (PBL) group as evidenced by the post-interest mean score of 37.29 compared to 26.98 in the conventional group and a mean gain score of 23.25 compared to 13.86 in the conventional group can be strongly linked not only to the instructional strategy but also to the relevance and applicability of the concept taught, namely, water quality and purification. This topic is inherently engaging and contributes to heightened student interest for several reasons:

1. Real-World Relevance:
   Water quality and purification are topics with direct practical significance in students' everyday lives. Access to clean water is a global concern, and by engaging with this concept, students perceive science not as an abstract discipline but as a tool for solving meaningful societal challenges. This relevance makes the learning experience more authentic and intrinsically motivating.
2. Hands-On Application:
   The PBL activity, which involved the construction of water settling tanks with filter beds, provided a tangible, hands-on experience that allowed students to see immediate results of their learning. The physical manipulation of materials and experimentation with purification processes fosters curiosity and a sense of accomplishment, enhancing both engagement and long-term interest in science.
3. Interdisciplinary Integration:
   Water purification integrates concepts from various scientific domains such as filtration, solubility, mixtures, and environmental science, allowing students to apply science in multidisciplinary contexts. This integrative experience deepens understanding and showcases the broader value of science.
4. Problem-Solving and Inquiry:
   Investigating and resolving water contamination problems through PBL supports inquiry-based learning, where students ask questions, formulate hypotheses, and experiment with solutions. This active,

problem-centered approach nurtures intellectual curiosity, a key component of sustained academic interest.

5. Personal and Community Impact: Understanding water purification empowers students to contribute to their communities by addressing real issues, thereby enhancing their sense of purpose and the relevance of education. When students feel their learning can have practical implications for themselves or others, their engagement and interest naturally increase.

This finding aligns with studies by Suryaningsih et al., (2022), Masbukhin et al., (2023), Dinda et al., (2024), and Sormin (2023), all of which reported enhanced student interest through the PBL model, particularly when topics were contextualized within real-life scenarios. Moreover, Hofstein and Mamlok-Naaman (2021) emphasized that student interest in science increases when instruction connects theory to everyday life and fosters experiential learning.

In contrast, the conventional method, which relies primarily on passive reception of information, lacked the experiential, student-centered elements necessary to stimulate the same level of interest. This discrepancy is reflected in the lower mean gain of 13.86 in the control group compared to 23.25 in the PBL group. While Jeffry et al. (2019) reported no significant difference in interest using PBL in certain contexts, likely, regional disparities, the nature of the PBL project, or differences in implementation fidelity may account for such variations. The concept of water quality and purification served as a powerful context for engaging students due to its personal relevance, real-world application, and interdisciplinary depth. When delivered through a PBL framework, it significantly enhanced students' interest in science by fostering active participation, critical thinking, and a tangible connection to their lived experiences.

Conclusion

Based on the findings of this study, it is concluded that Project-Based Learning (PBL**)** is an effective instructional strategy for improving students' conceptual understanding, academic performance, and interest in science. By actively engaging students in real-world problem-solving tasks such as constructing water purification systems, PBL promotes deeper cognitive processing and enhances students' motivation to learn abstract scientific concepts. This study contributes to the growing body of empirical evidence affirming that student-centered, inquiry-driven instructional approaches, such as PBL, are superior to conventional methods in fostering both academic achievement and sustained interest in science education. Importantly, it adds contextual relevance by demonstrating these benefits within the Nigerian secondary school system, thereby filling a gap in localized research on effective pedagogical strategies in science. The findings support the integration of PBL into the national science curriculum, encouraging curriculum developers (e.g., NERDC) to include real-life, interdisciplinary projects as core components of science syllabi. Given PBL's emphasis on process and application, there is a need to align assessment practices with performance-based evaluations, incorporating rubrics that measure critical thinking, collaboration, creativity, and conceptual understanding. By fostering autonomy and collaboration, PBL offers an inclusive approach that caters to diverse learning styles, potentially narrowing achievement gaps and increasing motivation across gender and ability levels. In summary, the findings of this study underscore the transformative potential of Project-Based Learning in science education. By confirming its effectiveness in enhancing conceptual understanding and stimulating student interest, the study provides compelling evidence base for educational reform. Policy makers, curriculum developers, and educators are thus urged to adopt and scale PBL strategies to improve science learning outcomes and foster 21st-century competencies among secondary school learners.

Recommendations

1. Instructional Planning: Teachers should incorporate project-based tasks that are locally relevant and aligned with curriculum objectives, making abstract Chemistry concepts more accessible and meaningful.
2. Teacher Training and Professional Development: Education ministries and teacher training institutions should design professional development programs that equip teachers with the skills to implement PBL effectively. Training should emphasize instructional design, facilitation skills, and the development of context-specific learning projects.

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References

Al-Rawi, H., & Zaytoon, A. (2023). The effect of a project-based learning strategy on the understanding of chemical concepts and the development of scientific thinking skills among basic stage students with varying motivation. *An-Najah University Journal for Research - B (Humanities)*, *30*(10), 1951–1996.

Bell, S. (2020). Project-based learning for the 21st century: Skills for the future. *The Clearing House*, *83*(2), 39–43. https://doi.org/10.1080/00098650903505415

Bradford, M. (2020). Motivating students through project-based service learning. *Technological Horizons in Education Journal*, *32*(6), 29–31.

Dinda, S., & Septiana, A. (2024). The impact of the project-based learning (PBL) method on motivation and interest in English learning among eleventh graders at SMAN 1 Karangrejo. *Jurnal Inovasi Sosial dan Pengabdian*, *1*(3), 99–109.

Eze, T., Onwusuru, I., & Ginigeme, O. (2021). Gender-relative effect of project-based learning method on academic achievement and retention of technical college students in basic electricity. *Journal of Technology and Vocational Education*, *6*(1), 85–93.

Gardner, H. (2021). Intelligence, creativity, ethics: Reflections on my evolving research interests. *Gifted Child Quarterly*, *55*(4), 302–304.

Haetami, A., Habiddin, S., Fahyuddin, B., Maysara, S., Marhadi, M., & Tewa, T. (2023). Influence of project-based learning models and logic mathematics on learning outcomes in basic chemistry. *Journal of Human University (Natural Sciences)*, *50*(5), 232–238.

Hofstein, A., & Mamlok-Naaman, R. (2021). High-school students' attitudes toward and interest in learning chemistry. *Chemical Education Journal*, *22*(2).

Jeffry, R., & Fauziah, S. (2019). Students' personal interest in project–based learning. *International Journal of Social Sciences*, *2*(1), 214–227.

Kalyoncu, R., & Tepecik, A. (2020). An application of project-based learning in an urban project topic in the visual arts course in the 8th class of primary education. *Educational Sciences: Theory and Practice*, *10*(4), 2409–2430.

Kızkapan, O., & Bektaş, O. (2017). The effect of project-based learning on seventh-grade students' academic achievement. *International Journal of Instruction*, *10*, 37–54.

Masbukhin, F., Adji, S., & Wathi, A. (2023). Project-based learning (PBL) model in chemistry learning: Students' perceptions. *European Journal of Education and Pedagogy*, *4*, 93–98.

Matilainen, R., Nuora, P., & Valto, P. (2021). Student experiences of project-based learning in an analytical chemistry laboratory course in higher education. *Chemistry Teacher International*, *3*(3), 229–238.

Omeje, C. O. (2023). The effect of project-based learning on secondary school students' academic achievement in electrochemical cells in Agbani education zone. *Journal of Science Education (JOSCED)*, *4*(1), 31–41.

Sormin, E. (2023). Efforts to increase students' interest in learning chemistry through the application of the project-based learning (PBL) learning method on the nature of chemical science materials. *MIJR: Multidisciplinary International Journal of Research*, *1*(1), 7–12.

Suryaningsih, S., Nisa, F., Muslim, B., & Aldiansyah, F. (2022). Learning innovations: Students' interest and motivation in STEAM-PjBL. *International Journal of STEM Education for Sustainability*, *2*, 66–77.

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