

Project- Based Learning and Secondary School Physics Students' Academic Achievement in Light Topics in Oyo Metropolis, Oyo State

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Abstract: One of the fundamental topics in Physics but found uninteresting by students is light. This birthed the need for a strategy to aid its teaching and learning, which this study focused on by determining the effect of project-based learning on academic achievement of secondary school physics students in light topics in Oyo metropolis. Guided by two research questions and two hypotheses, the study adopted a pre-test, post-test 2 X 2 quasi-experimental research design, consisting of two experimental groups and two control groups. The population of the study was 3751 Senior Secondary 2 (SS2) physics students in Oyo metropolis. A sample of 145 SS2 Physics students from four intact classes participated in the study via multi-stage and purposive sampling techniques: Experimental group (Urban, N=48, Rural, N=33) and Control Group (Urban N=37 Rural N=27) from the four selected schools. Data were collected using a validated Light Topic Achievement Test (LTAT) (KR-20=0.86). Research questions were answered using frequency counts and standard deviation, while ANCOVA was employed to test the hypotheses. The findings showed a significant effect of project-based learning strategy on the academic achievement of Physics students ($F_{(1,142)}=13.24$, $P=0.00 < 0.05$); and a significant interaction effect of project-based learning strategy on academic achievement of secondary school physics students on the bases of school location ($F_{(1, 142)} = 36.05$), $P=0.00 < 0.05$. The study concluded that project-based learning strategy was effective in teaching Light topics; and for teaching all school locations. It was recommended that physics educators should adopt Project-based learning strategy to enhance academic achievement in Light topics and at any school location.

Keywords: Project-based, Academic achievement, Light topic, School location, Secondary Schools

I. Introduction

Physics is a core subject in the science curriculum at the Senior Secondary School level (Oyelowo, 2023). As a fundamental science, physics plays a crucial role in understanding the natural world and forms the basis for many technological advancements (Chen, 2024). Physics as a core science subject is crucial as it lays the groundwork for students who wish to pursue careers in engineering, technology, medicine, and other science-related fields (Khong, 2022). The physics curriculum in Oyo State follows the guidelines provided by the Nigerian Educational Research and Development Council (NERDC)(Udofia, Ijeoma & Chukwuemeka-Nworu, 2021). This curriculum covers various topics such as Mechanics, Heat thermodynamics, Waves, Optics, Electricity, Magnetism, and Modern Physics (Badmus, Bada & Jita, 2022). The curriculum imparts theoretical knowledge and encourages practical understanding through laboratory experiments and hands-on activities.

Physics often requires collaborative problem-solving strategy and the ability to communicate complex ideas, such that, the effectiveness of the teaching strategy is showcased in promoting group work and discussions, where students can share ideas, challenge each other's thinking, and learn to articulate their understanding (Hisbollah & Hassan, 2022). Many students find Physics to be abstract, challenging, and difficult to grasp and this perception often leads to poor academic achievement and a lack of interest in the subject (Wangchuk, Wangdi, Tshomo & Zangmo, 2023). One of the major obstacles to effective Physics learning is the traditional teaching approach, which often focuses on theoretical explanations without providing sufficient opportunities for students to engage in hands-on, experiential learning (Hamed & Aljanazrah, 2020; Alifatun, Arianti, Suyanto, Putera & Nashrudin, 2024).

The performance of secondary school students in physics over the years have consistently been poor, especially in topics such as optics and light. Light topics involve the study of the properties and behaviours of light, including its nature, propagation, reflection, refraction, and various phenomena like colour and dispersion (Al-Khalili, 2020; Biazus & Mahtari, 2022). This observation is buttressed by the Chief Examiners' Reports on Physics for West African Senior School Certificate Examination, which indicated that students' performance in the light section of Physics examination has typically been poor, with some areas of difficulty for candidates such as reflection, refraction, diffraction, and the behaviour of light in various media (West African Examination Council, 2022; 2023).

One of the ways to encourage students' learning of Physics and enhance them to get improved results is by introducing an effective teaching strategy which can promote group work and discussions, where students can share ideas, challenge each other's thinking, and learn to articulate their understanding. One of such ways is by introducing student-centered strategies, which Project-based learning is one. Project-based learning is one of the effective student-centered learning strategies which allows students to learn by

doing (Barkley & Major, 2020; Mohammed, 2020). With project-based learning, students learning process within their learning environments is linked to daily life where students are required to establish their profiles and learn, while they solve real-life problems through previously acquired knowledge. Being a student-centered learning strategy which allows students to learn by doing, Project-based learning (PbL) attracts significant attention in educational settings due to its potential to engage students in active and inquiry-driven learning (Bogador, Camarao, Matunding & Sombria, 2024).

Project-based Learning (PbL) is an instructional approach that emphasizes learning through the active exploration of real-world challenges and problems. Unlike traditional teaching methods that often rely on passive learning through lectures and rote memorization, Project-based Learning engages students in hands-on projects that require them to apply knowledge and skills to create solutions to complex questions or problems (Bogador, Camarao, Matunding & Sombria, 2024). Project-based Learning shifts the focus from teacher-led instruction to student-driven exploration. Students take ownership of their learning by choosing the direction of their projects, setting goals, and managing their time and resources. Projects are designed to mimic real-world scenarios, making learning more meaningful and applicable to everyday life. This relevance helps students see the practical applications of their academic studies. Project-based Learning often involves group work, where students collaborate to achieve common goals. This teamwork helps develop essential communication and interpersonal skills, preparing students for collaborative environments in higher education and the workplace (Parrado-Martínez & Sánchez-Andújar, 2020; Yun 2022).

The bases for this study hinged on the fact that, there is limited empirical research known to the current researchers on how to improve the academic achievement of secondary school physics students in light concepts in Oyo State. By focusing on real-world problems and promoting collaboration, project-based learning encourages students to apply knowledge and skills in meaningful ways (Schulte, 2021; Mohammed & Abdullatif, 2020). This study seeks to examine the Effect of Project-based Learning (PbL) Strategies on Secondary School Physics Students' Academic Achievement in Light Topics in Oyo Metropolis, Oyo State.

Purpose of the study

The general purpose of this study is to investigate the effect of Project-based learning Strategies on Secondary School Physics Students' Academic Achievement in Light Topics in Oyo Metropolis, Oyo State.

The specific objectives are to:

- investigated the mean difference between the academic achievement of secondary school physics students in the experimental and control groups;
- examine the mean difference in the academic achievement between rural and urban secondary school physics students when exposed to Project-based learning;
- examine the effect of Project-based Learning strategy on secondary school physics students' academic achievement in light topic in Oyo metropolis, Oyo state; and
- determine the effect of Project-based Learning strategy on secondary school physics students' academic achievement in light topic on the basis of school location in Oyo metropolis, Oyo state.

Research Questions

What is the mean difference between the academic achievement of secondary school physics students in the experimental and control groups?

What is the mean difference in the academic achievement between rural and urban secondary school physics students when exposed to Project-based learning?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance.

H₀₁: There is no significant effect of project-based learning on the academic achievement score of secondary school Physics students in Oyo Metropolis, Oyo State.

H₀₂: There is no significant difference in the mean academic achievement score between rural and urban secondary school Physics students exposed to Project-based learning.

II. Methodology

The research design adopted for this study was pre-test, post-test quasi-experimental design. The population of the study was 3751 Senior Secondary School II physics students in Oyo metropolis, from both urban and rural settlement of the Oyo Metropolis. The sample consisted of 145 Senior Secondary School (SS2) students from four intact classes, with the Experimental group (Urban, N=48; Rural, N=33) and Control Group (Urban, N=37; Rural, N=27) from the four schools selected using multi-stage and purposive sampling technique, the four schools were selected from both rural and urban settlement to address the issue of school location, while in each location, one (1) school was considered as Experimental Group (Project-based Learning PbL) and one school stood

for Control Group using the traditional method. The experimental groups, were taught topics on light using Project- based Learning (PbL), while the control groups were taught the same topics using traditional method of teaching.

The sampled schools were considered for their availability of Physics laboratory facilities. The instruments used for data gathering was Light Topic Achievement Test (LTAT) designed by the researcher which cover key concepts such as the nature of light, Reflection, refraction, and dispersion of light, Laws of reflection and refraction, and practical applications of light. The LTAT was developed based on the Physics curriculum for secondary schools, which consisted 30 multiple-choice questions with options A to D. The instrument was validated by three experts in Science Education, measurement and evaluation at Lead City University, Ibadan Nigeria and two secondary school Physics teachers. This was in order to ensure the face and content validity of the instrument for effective data gathering. To determine the reliability of the instrument, a pilot study was conducted on a group of students outside the participating schools within Oyo metropolis and a reliability coefficient of 0.86 was obtained using Kuder Richardson-20 (KR-20). The analysis of the results was done using frequency counts, arithmetic means and standard deviations to answer the research questions, while Analysis of Covariance (ANCOVA) was employed to test the formulated hypotheses at 0.05 level of significance.

III. Results

Research Question One: What is the mean difference between the academic achievement of secondary school physics students in the experimental and control groups?

Table 1: Mean and Standard Deviation of Academic Achievement of Secondary School Physics Students in Experimental and Control Groups

Group	N	Mean	Standard Deviation
Experimental	80	30.23	7.39
Control	65	35.54	7.30
Mean Difference		5.21	

Table 1 revealed a mean difference of 5.21 in the academic achievement of secondary school physics student between the experimental (Project-based Learning) and control (Traditional Learning) group, which clearly indicate that the Project-based does not significantly influence the academic achievement of physics students since the control has a higher mean than the experimental group.

Research Question Two: What is the mean difference in the academic achievement between rural and urban secondary school physics students when exposed to Project-based learning?

Table 2: Mean and Standard Deviation of the Academic Achievement between Rural and urban Secondary School Physics Students When Exposed to Project-based Learning

Location	N	Mean	Standard Deviation
Urban	80	35.95	7.26
Rural	65	27.87	5.86
Mean Difference		8.08	

Table 2 showed a mean difference of 8.08 between the academic achievements of secondary school physics students on the basis of school location when they are exposed to project-based learning. The urban students indicate a better achievement than the students in the rural setting, this could be due their accessibility to materials in the urban location.

Hypothesis One (H₀₁): There is no significant effect of project-based learning on the academic achievement score of secondary school Physics students in Oyo Metropolis, Oyo State.

Table 3: Analysis of Covariance of Academic Achievement Scores of Secondary School Physics Students in the Experimental and Control Groups

Source	Type III Sum of Squares	df	Mean Square	F	Sig	Partial Eta Square
Corrected Model	2492.199 ^a	2	2492.199 ^a	28.291	0.00	0.285

Intercept	4061.233	1	4061.233	92.206	0.00	0.394
Pretest	1479.709	1	1479.709	33.595	0.00	0.191
Group	583.207	1	583.207	13.241	0.00	0.085
Error	6254.395	142	44.045			
Total	162912.000	145				
Corrected Total	8746.593	144				

a. R Squared = .285 (Adjusted R Squared = 0.275)

Table 3 indicated that $F_{(1; 142)}=13.24$, $P=0.00<0.05$, which showed a significant difference in the academic achievement of secondary school physics students when exposed to project-based learning. This shows that the null hypothesis one which stated that, there is no significant effect of project-based learning on the academic achievement score of secondary school Physics students in Oyo Metropolis, Oyo State is rejected

Hypothesis Two (H₀₂): There is no significant difference in the mean academic achievement score between rural and urban secondary school Physics students exposed to Project-based learning.

Table 4: Analysis of Covariance on Mean Academic Achievement Score among Rural and Urban Secondary School Physics Students Exposed to Project-based Learning

Source	Type III Sum of Squares	df	Mean Square	F	Sig	Partial Eta Square
Corrected Model	3293.303 ^a	2	1646.651	42.878	0.00	0.377
Intercept	4483.219	1	4483.219	116.740	0.00	0.514
Pretest	993.455	1	993.455	25.869	0.00	0.154
Location	1384.311	1	1384.311	36.047	0.00	0.202
Error	5453.290	142	38.403			
Total	162912.000	145				
Corrected Total	8746.593	144				

a. R Squared = 0.377 (Adjusted R Squared =0 .368)

Table 4 showed that $F_{(1; 142)}=36.05$, $P=0.00<0.05$, which indicted that, there is significant difference in the mean academic achievement score of secondary school physics students on bases of school location. Therefore, the null hypothesis which stated that, 'There is no significant difference in the mean academic achievement score between rural and urban secondary school Physics students exposed to Project-based learning' is rejected.

IV. Discussion of Findings

The findings of this study showed that, project-based learning strategy did not significantly affect the academic achievement of secondary school physics students. This is clearly indicated in table1 which revealed a mean difference of 5.21 in the academic achievement of secondary school physics student between the experimental (Project-based Learning) and control (Traditional Learning) group, which clearly indicate that the Project-based did not significantly affect the academic achievement of physics students since the control has a higher mean than the experimental group.

Table 2 also showed a mean difference of 8.08 between the academic achievements of secondary school physics students on the basis of school location when they were exposed to project-based learning. The urban students displayed better achievement than the students in the rural setting, this could be due their accessibility to materials in the urban location. It also revealed from table 3 that $F_{(1; 142)}=13.24$, $P=0.00<0.05$, which indicate a significant difference in the academic achievement of secondary school physics students when exposed to project-based learning. This shows that the null hypothesis one which stated that, there is no significant effect of project-based learning on the academic achievement score of secondary school Physics students in Oyo Metropolis, Oyo State is rejected in line with the findings of a study on Problem-Based Learning (PBL) methods within an independent curriculum, which revealed that students in project-based science classes tend to improve their ability to communicate scientific ideas effectively, both orally and in writing, as they must present their findings to peers, teachers, or the broader community (Alifatur, Arianti, Suyanto, Putera & Nashrudin, 2024).

It also agreed with the research conducted using a quasi-experiment using project-based learning and direct instructional learning models and found that the PBL model had a significant impact on the enhancement of creative thinking skills of secondary school students (Biazus & Mahtari, 2022). In similar vein, this study contrasted the findings that collaboration in Project-based Learning improved the academic performance of Physics students in secondary schools in Nigeria (Mohammed & Abdullatif, 2020). In another study by Parrado-Martínez and Sánchez-Andújar (2020), using the fifth-grade project "Searching for Roots. Project-based learning was used as an example to discuss that project-based in-depth ritual education can develop students' core literacy. Yun (2022) explored the effects of project-based learning on ninth-grade students' writing skills and found that cooperative work in project-based learning potentially promoted students' critical thinking, communication, and collaboration skills, significantly improving middle school students' English writing skills.

Table 4 showed that, $F_{(1; 142)} = 36.05$, $P = 0.00 < 0.05$, which indicted a significant difference in the mean academic achievement score of secondary school physics students on bases of school location. The null hypothesis two which stated that, "there is no significant difference in the mean academic achievement score between rural and urban secondary school Physics students exposed to Project-based learning" was rejected. The finding was in line with the findings of Mohammed (2020) but in contrast with the submission of Bogador, Camarao, Matunding and Sombria (2024).

V. Conclusion

from the findings of this study, it is concluded that Project-based learning significantly affected the academic achievement of secondary school physics students and the school location can also influence the academic achievement of students. This indicates that students in the urban schools performs significantly higher than the students in the rural schools, this could be do to the fact that the students in the urban schools have easy aces to some resource that can enhances their project-based learning strategies. The study therefore concluded that project-based learning strategy was effective in teaching Light topics; and for teaching all school locations.

VI. Recommendations

It is recommended from the study that:

- Project-based learning should be employed to teach light topics in Physics in Oyo Metropolis;
- Schools located at the rural should be equipped with necessary tools and equipment to teach light topics effectively in Oyo Metropolis, Oyo State;
- physics educators should adopt Project-based learning strategy to enhance academic achievement in Light topics and at any school location, and
- teachers in schools located at the rural should be adopt project-based learning frequently to teaach light topics effectively in Oyo Metropolis, Oyo State.

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