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Student- Center Laboratory And Academy Performance Of Senior Secondary School Science Students In Delta State

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Keywords

Student-Centered Learning, Laboratory-Based Instruction, Science Education and Academic Performance.

Abstract

This study investigated student- center laboratory and academy performance of senior secondary school science students in Delta State. Nigeria. In line with aim of the study three (3) research questions and two (2) hypotheses guided the study. The study adopted a quasi-experimental research design with a pre-test and post-test control group approach. The population of this study comprises senior secondary school students offering science subjects (Physics, Chemistry, and Biology) in selected secondary schools across Delta State. A total of 200 students were selected using a purposive sampling technique, ensuring that participants come from schools with functional science laboratories. The sample was divided into two groups: Experimental Group (100 students), received instruction through student-centered laboratory practices, involving hands-on activities, group collaboration, and inquiry-based learning. Why Control Group (100 students), were taught using traditional teacher-centered methods, with more emphasis on lectures and theoretical explanations. The instrument for data collection was a Science Achievement Test (SAT) designed to measure students' understanding and performance in science subjects. The post-test results were analyzed using Mean and Standard Deviation why Paired Sample t-Test was used to determine if there is a significant difference in the performance of students before and after the intervention. The findings of the study shows that; student-centered laboratory practices significantly improve the academic performance of science students. However the study recommended among others that government and educational stakeholders should invest in modern laboratory facilities in secondary schools to ensure that students have access to the necessary equipment for practical learning.

Introduction

The academic performance of students in science subjects plays a crucial role in shaping their overall education and future career opportunities. Science subjects, such as physics, chemistry, and biology, provide foundational knowledge that is essential for careers in medicine, engineering, and technology-related fields (Adeyemo, 2019). However, in Delta State, many students struggle with these subjects due to various challenges, including a lack of motivation, inadequate learning resources, and ineffective teaching strategies. Addressing these issues is essential to ensuring that students can grasp scientific concepts effectively and apply them in real-world situations. A key aspect of improving science education lies in adopting modern teaching approaches that enhance student engagement and comprehension.

Science education in Delta State, like in many other parts of Nigeria, is hindered by several challenges. Poor infrastructure in schools means that students often lack access to well-equipped

laboratories, making it difficult for them to conduct experiments and develop hands-on experience. Additionally, outdated teaching methods, such as rote memorization and teacher-centered instruction, limit students' ability to critically analyze scientific problems. Many teachers rely heavily on textbooks and theoretical explanations, which do not always translate into meaningful learning for students. Furthermore, limited opportunities for practical learning prevent students from developing essential skills, leading to a decline in academic performance in science subjects. (Aina, 2021).

To address these challenges, student-centered learning has been proposed as an effective alternative to traditional teaching methods. This approach prioritizes active student participation, collaboration, and the development of critical thinking skills. In a student-centered classroom, learners take ownership of their education by engaging in discussions, conducting experiments, and working in groups to solve scientific problems. The emphasis is placed on inquiry-based learning, where students explore scientific concepts through hands-on activities rather than passively receiving information, (Akintoye, & Igwe, 2022). Research suggests that this method enhances students' understanding, retention, and application of knowledge, ultimately leading to improved academic performance.

According to Chukwu and Eze, (2020), one of the most promising applications of student-centered learning in science education is the integration of laboratory practices into the curriculum. When students actively engage in laboratory work, they gain firsthand experience with scientific concepts, allowing them to better understand abstract theories. Laboratory experiments encourage curiosity, creativity, and problem-solving, which are essential skills for scientific inquiry.

Moreover, practical learning environments foster a deeper interest in science subjects, making students more motivated to excel. Schools that have adopted student-centered laboratory practices have reported improved student performance, increased enthusiasm for science, and better preparation for higher education and careers in STEM fields. This research aims to assess the impact of student-centered laboratory practices on the academic performance of science students in Delta State. By examining how hands-on learning experiences influence students' understanding and application of scientific concepts, this study seeks to provide insights into effective teaching strategies for science education. The findings will help educators and policymakers make informed decisions about integrating student-centered approaches into the science curriculum. If proven effective, this method could serve as a model for improving science education in other regions facing similar challenges.

Ultimately, enhancing science education through innovative teaching methods will contribute to the overall development of students and prepare them for successful careers in the ever-evolving world of science and technology.

Statement of the Problem

Although practical work is widely acknowledged as essential in science education, students in Delta State continue to struggle with their performance in science subjects. Conventional teacher-centered instructional methods have proven inadequate in fostering deep comprehension and active student involvement in learning. To address this issue, there is a growing need to adopt student-centered teaching strategies in science laboratories to enhance student engagement, improve learning experiences, and boost academic achievement. This research aims to evaluate the impact of student-centered laboratory practices on the academic performance of science students in Delta State.

Aim and Objective of the Study

The aim of this study is to investigate how student-centered laboratory practices influence the academic performance of students in science subjects in Delta State. Specifically, the objectives of the study are:

1. To examine the correlation between student-centered laboratory practices and academic performance in science subjects.

2. To assess students' perceptions of the effectiveness of student-centered teaching methods in science laboratories.
3. To determine the challenges faced by both students and teachers in adopting student-centered practices in the science classrooms and laboratories.

Research Questions

1. To what extent do student-centered laboratory practices improve the academic performance of science students in Delta State?
2. What are students' perceptions of student-centered approaches in science laboratories?
3. What are the challenges faced by science students and teachers in implementing student-centered laboratory methods?

Hypothesis

1. There is no significant relationship between student-centered laboratory practices and the academic performance of science students in Delta State.
2. There is a significant positive relationship between student-centered laboratory practices and the academic performance of science students in Delta State.

Empirical Review

Akintoye and Igwe (2022) investigated the effect of student-centered learning on academic achievement in science subjects in Nigerian tertiary institutions. Their findings revealed that students exposed to interactive and participatory learning methods performed significantly better than those taught using traditional lecture-based methods. Similarly, Eke (2020) examined the role of student-centered learning in enhancing academic performance in science subjects and found that students involved in practical activities, group discussions, and real-world problem-solving showed improved conceptual understanding and retention. Okafor and Agwu (2017) conducted a study in Delta State to determine the relationship between active learning strategies and students' academic performance. Their results demonstrated a positive correlation between inquiry-based learning and higher test scores in physics, chemistry, and biology. Okonofua and Omotayo (2019) extended this analysis by exploring student-centered learning in Nigerian secondary schools, concluding that student engagement and motivation were significantly enhanced when active learning techniques were employed.

Onyema and Smith (2021) studied the role of hands-on laboratory practices in improving students' understanding of scientific concepts. Their findings showed that students who participated in laboratory-based experiments outperformed their peers who relied solely on theoretical instruction. This aligns with the work of Adeyemo (2019), who demonstrated that inquiry-based learning strategies help students develop critical thinking skills and a deeper understanding of scientific principles.

Chukwu and Eze (2020) compared the effectiveness of traditional and student-centered teaching strategies in improving biology students' performance. The study revealed that students in the experimental group, who engaged in hands-on learning, scored significantly higher than those in the control group, who received teacher-centered instruction.

Similarly, Ekong (2018) emphasized the benefits of constructivist approaches in science teaching, noting that students who actively participated in knowledge construction performed better in problem-solving tasks than their counterparts in passive learning environments.

Ibe and Okafor (2022) examined the role of experiential learning in cognitive retention and found that inadequate laboratory facilities and a lack of trained science teachers hindered effective implementation. Odukoya (2019) supported this view, highlighting that insufficient funding, overcrowded classrooms, and time constraints often limit the adoption of hands-on learning methods in Nigerian secondary schools.

Olaleye and Ogunbanjo (2020) explored student engagement in active learning environments and found that while student-centered approaches increased motivation, many teachers lacked the necessary skills to facilitate inquiry-based instruction effectively. Omole (2021) further emphasized that inadequate teacher training and rigid curriculum structures often prevent the full integration of student-centered laboratory practices in science education. Uchenna and Okeke (2019) suggested that government policies should prioritize the provision of well-equipped laboratories, continuous teacher training, and curriculum reforms to support student-centered learning. Yusuf (2023) reinforced this argument by recommending increased investment in science education infrastructure and the adoption of technology-enhanced learning tools to complement laboratory-based instruction.

Despite extensive research on student-centered learning and its impact on academic performance, gaps remain, particularly in the context of secondary school students in Delta State. Previous studies have largely focused on tertiary institutions or broader educational settings without examining the localized impact of student-centered laboratory practices on science achievement in Delta State. Many studies rely on correlational designs rather than quasi-experimental approaches, limiting causal inferences. Furthermore, while research acknowledges the benefits of hands-on learning, there is insufficient exploration of students' perceptions and the challenges of implementing student-centered methods, such as inadequate laboratory facilities and lack of trained teachers. This study addresses these gaps by employing a quasi-experimental design, integrating qualitative insights on student engagement, and providing evidence-based recommendations for overcoming implementation barriers in Delta State's secondary schools.

Methodology

The study adopted a quasi-experimental research design with a pre-test and post-test control group approach to assess the impact of student-centered laboratory practices on the academic performance of science students in Delta State. This design allows for the comparison of students exposed to student-centered laboratory learning (experimental group) with those taught using traditional methods (control group) to determine any significant differences in performance. The population of this study comprises senior secondary school students offering science subjects (Physics, Chemistry, and Biology) in selected secondary schools across Delta State. The study targeted students in SS2 because they have foundational knowledge of science subjects and are preparing for senior secondary external examinations. A total of 200 students were selected using a purposive sampling technique, ensuring that participants come from schools with functional science laboratories. The sample was divided into two groups: Experimental Group (100 students), received instruction through student-centered laboratory practices, involving hands-on activities, group collaboration, and inquiry-based learning. Why Control Group (100 students), were taught using traditional teacher-centered methods, with more emphasis on lectures and theoretical explanations. The selected schools were chosen using a stratified random sampling technique to ensure representation from different geographical locations within Delta State (urban and rural schools).

The instrument for data collection was a Science Achievement Test (SAT) designed to measure students' understanding and performance in science subjects. The SAT consists of multiple-choice and short-answer questions covering key concepts in Physics, Chemistry, and Biology. The test was administered as both a pre-test (before the intervention) and a post-test (after the intervention). The test instrument was subjected to content and face validity by a panel of experts in science education and educational measurement to ensure it accurately assesses students' knowledge and skills. A pilot study was conducted in a school outside the study sample to test the reliability of the instrument using the test-retest method, and the reliability coefficient of 0.78 was determined using Cronbach's Alpha to ensure consistency in results. The Science Achievement Test (SAT) was administered to both the

experimental and control groups to assess their initial level of academic performance. The pre-test provided baseline data on students' understanding of key scientific concepts before the intervention.

The experimental group participated in student-centered laboratory learning for a period of six weeks, engaging in hands-on experiments, collaborative problem-solving, and inquiry-based activities. Meanwhile, the control group continued with traditional teacher-centered instruction, relying primarily on lectures and theoretical explanations. Following the intervention, the SAT was re-administered to both groups to measure changes in their academic performance. The post-test results were analyzed using Mean and Standard Deviation why Paired Sample t-Test was used to determine if there is a significant difference in the performance of students before and after the intervention.

Results

The study's results and discussion of the findings are covered in detail in this section. The following tables provide the information and findings

Table 1: Post-Test Scores Analysis for Experimental and Control Groups (N=200)

Group	N	Mean Score (M)	Standard Deviation (SD)
Experimental	100	32.5	3.8
Control	100	24.6	4.2

Table 1: The **experimental group** (student-centered laboratory approach) had a **higher mean score (M = 32.5)** compared to the **control group (M = 24.6)**. The **standard deviation (SD = 3.8 for experimental, 4.2 for control)** indicates the variability in students' performance. This suggests that students exposed to student-centered laboratory practices performed **better on average** than those taught using traditional methods.

Table 2: Paired Sample t-Test for Pre-Test and Post-Test Scores of the Experimental Group (N=200)

Test	N	Mean (M)	SD	t-value	p-value	Decision
Pre-Test	100	21.8	4.5	**12.34**	**0.000**	Reject H_0
Post-Test	100	32.5	3.8			

Table 2: A Paired Sample t-Test was conducted to determine if there was a significant difference between students' scores before and after the intervention. The t-value (12.34) and p-value ($0.000 < 0.05$) indicate a statistically significant improvement in students' performance after exposure to student-centered laboratory practices. Since the p-value is less than 0.05, hence the null hypothesis (H_0) was rejected and the alternative hypothesis was accepted indicating that student-centered laboratory practices significantly improve academic performance.

Discussion of Findings

The findings of this study indicate that student-centered laboratory practices significantly improve the academic performance of science students in Delta State. The results showed that the experimental group, which was exposed to hands-on, inquiry-based, and collaborative laboratory activities, performed better (M = 32.5) than the control group, which relied on traditional teacher-centered methods (M = 24.6). This confirms that engaging students actively in laboratory work enhances their understanding of scientific concepts, promotes critical thinking, and fosters problem-solving skills. The statistical analysis using a paired sample t-test further validated these findings, showing a significant improvement in students' performance after the intervention ($p < 0.05$).

Students' perceptions of student-centered learning approaches were generally positive. Qualitative feedback from students revealed that they found the interactive and practical nature of the laboratory sessions more engaging and beneficial compared to traditional lectures. Many students

expressed that hands-on experiments helped them grasp abstract scientific concepts more easily, making learning more enjoyable and less intimidating. This aligns with constructivist learning theories, which emphasize active participation and experiential learning as key to deepening students' knowledge and retention. These findings suggest that shifting from passive to active learning environments in science education can enhance student motivation and overall academic achievement.

The study supports the argument that student-centered laboratory learning significantly enhances academic performance in science subjects. The rejection of the null hypothesis (H_0) and acceptance of the alternative hypothesis (H_1) reinforce the importance of hands-on learning in improving students' comprehension and problem-solving abilities.

Conclusion

This study examined the impact of student-centered laboratory practices on the academic performance of science students in Delta State. The findings revealed that students who participated in hands-on, inquiry-based laboratory activities performed significantly better than those taught using traditional teacher-centered methods. The experimental group demonstrated a higher mean score ($M = 32.5$) compared to the control group ($M = 24.6$), confirming the effectiveness of student-centered learning in improving science education outcomes. Additionally, students' qualitative feedback indicated that they found the interactive nature of student-centered approaches more engaging and beneficial in understanding scientific concepts.

However, several challenges were identified in implementing student-centered laboratory methods, including inadequate laboratory facilities, a lack of trained teachers, and time constraints. Despite these challenges, the statistical analysis supported the effectiveness of student-centered learning, as the null hypothesis (H_0) was rejected ($p < 0.05$), confirming a significant improvement in students' academic performance. These findings highlight the need for a shift in teaching strategies, emphasizing practical and inquiry-based learning to enhance student engagement and comprehension of science subjects.

Recommendations

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

1. The government and educational stakeholders should invest in modern laboratory facilities in secondary schools to ensure that students have access to the necessary equipment for practical learning. This will help bridge the gap between theoretical knowledge and real-world scientific applications.
2. Regular workshops and training programs should be organized for science teachers to enhance their skills in implementing student-centered laboratory practices. This will equip them with the necessary knowledge and strategies to effectively engage students in hands-on learning activities.
3. The curriculum should be revised to incorporate more practical, inquiry-based activities that align with student-centered learning approaches. This will ensure that science education moves beyond rote memorization and focuses on developing critical thinking and problem-solving skills.
4. Schools should allocate more time for science practical's within the academic calendar to allow students to fully engage in laboratory activities. This may include adjusting lesson schedules to accommodate extended practical sessions without disrupting other subjects.

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