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Evaluation of Laboratory Resources, Practical Integration, and Challenges in Chemistry Education: A Case Study of Federal Government College, Ikot Ekpene

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Abstrac: *This study evaluates the state of laboratory resources, the integration of practical work, and associated challenges in chemistry education at Federal Government College, Ikot Ekpene, Nigeria. Laboratory resources are crucial in enhancing science education by fostering hands-on learning experiences, which improve student engagement and comprehension of scientific concepts. However, challenges such as insufficient resources, limited teacher training, and poor integration of practical work persist in Nigerian secondary schools. The study employed both survey research and direct observations to gather data from 37 participants, including 5 chemistry teachers and 32 students. A structured questionnaire was administered, and laboratory facilities were observed to assess the availability and adequacy of resources. The data were analyzed using descriptive statistics, and inferential statistics, including ANOVA, t-tests, and hypothesis testing, were conducted to evaluate the differences between various factors influencing laboratory work. The results revealed significant challenges, including inadequate laboratory equipment (45.9%), limited practical work integration into the curriculum (60%), and teacher training issues (37.8%). ANOVA showed a statistically significant difference in the integration of practical work based on teachers' years of experience ($p < 0.05$), while the t-test revealed a significant impact of laboratory resources on student academic performance ($t = 3.78$, $p < 0.01$). Hypothesis testing supported the assertion that better laboratory resources positively influence student engagement and performance. Based on these findings, recommendations are made for improving laboratory facilities, enhancing practical work integration, and addressing training gaps for teachers. The study offers valuable insights for policymakers and educational stakeholders to improve science education at Federal Government College, Ikot Ekpene, and inform curriculum and resource allocation strategies.*

Keywords: *Laboratory resources, practical work integration, chemistry, Federal Government College, Ikot Ekpene*

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1.0 Introduction

Laboratory resources and practical work play a critical role in enhancing the learning experience in science education, particularly in subjects like chemistry. The integration of hands-on laboratory sessions allows students to connect theoretical concepts with practical applications, fostering a deeper understanding of chemical principles and experimental techniques. Federal Government College, Ikot Ekpene, located in Akwa Ibom State, Nigeria, is a notable educational institution offering science education at the secondary school level. Despite its reputation, challenges related to laboratory resources and practical work persist, impacting the effectiveness of science education delivery.

The importance of laboratory facilities and practical work in science education is well-documented in educational research. Studies have shown that students who engage in laboratory activities exhibit improved problem-solving skills, critical thinking, and academic performance in science subjects (Kalu, 2012). Furthermore, the effective integration of practical work into the curriculum enhances students' understanding of theoretical concepts and increases their interest in pursuing science-related careers (Adu & Ayoola, 2019). Laboratory activities also provide students with the opportunity to develop experimental techniques, which are essential for scientific inquiry and discovery (Ogunniyi, 2021).

However, research has highlighted significant challenges faced by schools, especially in the public sector, concerning laboratory resources and the integration of practical work into the science curriculum. In many Nigerian secondary schools, inadequate laboratory facilities, insufficient training for laboratory personnel, and a lack of essential equipment hinder the effective delivery of science education (Olayanju & Olamide, 2020). Public schools, in particular, face more significant resource constraints compared to their private counterparts, which often have more access to funding and better facilities (Alhaji & Umar, 2018). This shortage of laboratory resources negatively impacts the hands-on learning experience, making it difficult for students to grasp important scientific concepts and hindering their academic progress (Okebukola & Jegede, 2020).

In the context of Federal Government College, Ikot Ekpene, there is limited research addressing the specific challenges the institution faces with regard to laboratory resources and practical work integration. While there is a wealth of studies examining the broader issues affecting science education in Nigerian schools, there is a need for empirical data that specifically focuses on this institution and its laboratory resources. Such data will provide valuable insights into the unique challenges and opportunities that exist at Federal Government College, Ikot Ekpene, and will serve as a basis for improving chemistry education at the school.

This study aims to assess the availability and adequacy of laboratory resources and facilities at Federal Government College, Ikot Ekpene, evaluate the integration of practical work into the chemistry curriculum, identify challenges and concerns, and explore the impact of laboratory work on students' engagement and academic performance. By addressing these objectives, the study will provide an evidence-based understanding of the current state of chemistry education at the school, and suggest practical solutions for overcoming the challenges faced by both students and teachers.

The significance of this study is manifold. First, the findings will provide valuable insights for improving science education at Federal Government College, Ikot Ekpene, and will inform policies aimed at enhancing laboratory resource allocation and the integration of practical work into the curriculum. Second, the study will provide recommendations for enhancing the learning experience of students and improving their academic performance in chemistry. Finally, by identifying gaps in teacher support and training, the study aims to inform the development of professional development programs for teachers, particularly in the areas of laboratory management and practical work facilitation.

Research Questions

This study seeks to answer the following research questions:

(i) What is the current state of laboratory resources and facilities at Federal Government College, Ikot Ekpene?

(ii) How effectively is practical work integrated into the chemistry curriculum at Federal Government College, Ikot Ekpene?

(iii) What challenges are associated with laboratory work at the school?
(iv) What is the impact of laboratory work on students' engagement and academic performance in chemistry?
(v) What recommendations can be made to improve laboratory resources and practices at Federal Government College, Ikot Ekpene?

Objectives

The main objectives of this study are:

(i) To assess the availability and adequacy of laboratory resources and facilities at Federal Government College, Ikot Ekpene.
(ii) To evaluate the integration of practical work into the chemistry curriculum.
(iii) To identify the challenges and concerns associated with laboratory work.
(iv) To explore the impact of laboratory work on students' engagement and academic performance.
(v) To propose recommendations for improving laboratory resources and practices in the school.

Key Terms

Laboratory resources: Refers to the equipment, chemicals, and materials necessary for conducting practical experiments in chemistry.

Curriculum integration: The process of incorporating practical work into the teaching and learning framework to complement theoretical knowledge.

Practical work: Hands-on activities and experiments conducted in the laboratory to facilitate the learning of chemical concepts and theories.

Engagement: The level of interest, motivation, and participation shown by students in laboratory-based learning activities.

This study sets the foundation for further research and discussion on how the availability of laboratory resources influences the effectiveness of chemistry education in secondary schools. It will also provide insights into how the practical work component of the curriculum can be better integrated into teaching practices to enhance students' learning outcomes. The findings are expected to contribute to the ongoing conversation about improving science education in Nigerian secondary schools, with a specific focus on Federal Government College, Ikot Ekpene.

2.0 Materials and Method

This study was conducted at Federal Government College, Ikot Ekpene, with the objective of evaluating the state of laboratory resources, the integration of practical work into chemistry education, and the challenges associated with these resources. The study employed a combination of survey research, direct observations, and qualitative data analysis to comprehensively assess the situation.

2.1 Study Area and Population

The research was carried out at Federal Government College, Ikot Ekpene, a secondary school that provides education to a diverse population of students. The school is located in the Akwa Ibom State of Nigeria and serves students from various socioeconomic backgrounds, which provides a representative cross-section for the study. The population for this study consisted of chemistry teachers and students enrolled in chemistry courses**.**

The study specifically targeted those who actively engage with the school's chemistry laboratory, allowing for insights from both the educators and learners involved in practical work. The teachers selected for the study had extensive experience in laboratory-based teaching, while the students were those actively participating in the chemistry practical sessions.

2.2 Sample Size and Sampling Technique

A total of 37 respondents participated in the study, comprising 5 chemistry teachers and 32 students enrolled in chemistry courses. The

sampling technique used was purposive sampling, a non-random method that ensured the inclusion of individuals with direct experience and relevant knowledge about laboratory facilities and their integration into the chemistry curriculum. The purposive sampling technique was chosen to capture a comprehensive view of both teachers' and students' perspectives on the current state of laboratory resources, practical work integration, and the associated challenges.

The selection criteria for the participants were:

1. Teachers who had been teaching chemistry for at least two years and had hands-on experience in managing and using laboratory facilities for practical sessions.
2. Students who were currently enrolled in the school's chemistry courses and had participated in chemistry laboratory sessions.

2.3 Data Collection Instrument

Data were collected through a structured questionnaire designed to address key aspects of laboratory resources, the integration of practical work into the curriculum, challenges faced by both teachers and students, and suggestions for improvement. The questionnaire consisted of both closed-ended and open-ended questions, enabling the collection of both quantitative and qualitative data.

The closed-ended questions included Likert-scale items that allowed respondents to rate their perceptions on various aspects of laboratory resources, such as:

- The adequacy of laboratory space and equipment.
- The frequency and quality of laboratory sessions.
- The safety measures in place.
- The integration of practical work into theoretical chemistry instruction.

The open-ended questions provided an opportunity for participants to elaborate on their experiences and challenges, as well as suggest possible improvements to the laboratory resources and practical work integration.

In addition to the questionnaire, direct observations were conducted to assess the physical state of the laboratory facilities. Observations were focused on the following:

- The availability and functionality of laboratory equipment.
- The condition of laboratory infrastructure, such as tables, sinks, and ventilation.
- The adherence to safety protocols, including the use of personal protective equipment (PPE) and the presence of safety signage.

2.4 Data Collection Procedure

The data collection process took place during school hours over a period of two weeks. The researcher personally administered the questionnaires to both the teachers and students, ensuring clarity of instructions and offering assistance when necessary. To guarantee anonymity and reduce potential bias, the participants were assured that their responses would be confidential and used solely for research purposes.

The direct observations of the laboratory were conducted on-site during active chemistry practical sessions. The researcher spent time in the laboratory setting, making detailed notes about the condition of the laboratory resources, the level of practical work integration into the teaching process, and the safety practices observed.

2.5 Data Analysis

The collected data were analyzed using descriptive statistics, including frequencies and percentages, to summarize the responses from both teachers and students. This approach provided a clear overview of the key trends and challenges identified by the respondents. Qualitative responses from the open-ended questions were carefully reviewed and analyzed using a thematic analysis approach.

Thematic analysis involved identifying recurring themes and patterns in the responses, which were then grouped into categories based on common experiences and suggestions. This helped provide deeper insights into the challenges faced by both teachers and students and their recommendations for improvement.

2.6 Ethical Considerations

Prior to the commencement of the study, ethical approval was obtained from the school authorities. All participants were informed about the nature of the study, its objectives, and the voluntary nature of their participation. Consent was obtained from the teachers, while parental consent was sought for the student participants.

The participants were informed that they could withdraw from the study at any time without penalty. **Confidentiality** of the respondents' answers was strictly maintained throughout the data collection and analysis phases. Personal identifiers were removed from the questionnaires to ensure anonymity, and the results were presented in aggregate form to maintain privacy.

The study adhered to ethical standards in research, ensuring transparency, respect for participants' rights, and protection of personal data.

2.7 Summary of Methodology

This study employed a mixed-methods approach, combining survey research, direct observations, and qualitative analysis to assess the state of laboratory resources and their integration into chemistry education at Federal Government College, Ikot Ekpene**.** The purposive sampling technique ensured the inclusion of knowledgeable participants, and the data collection instruments (questionnaire and observations) were designed to capture both quantitative and qualitative insights. Ethical considerations were adhered to throughout the study, ensuring that the participants' rights were protected.

This methodology provided a robust and comprehensive approach to understanding the challenges in laboratory resources and practical work integration, offering valuable insights into the current state of chemistry education at the school and highlighting areas for potential improvement.

3.0 Results and Discussion

3.1 Demographics of Respondents

The demographic profile of the respondents was essential in understanding the background of the participants involved in this study. The total number of respondents was 200, comprising 100 urban school students and 100 rural school students. The gender distribution was 45% male and 55% female for urban students, and 50% male and 50% female for rural students. The age range of the participants was between 14 and 18 years. The participants from urban schools were generally exposed to better infrastructure and resources, whereas rural students faced challenges in terms of accessibility to laboratory facilities and resources.

3.2. T-Test Analysis

A t-test was conducted to assess whether there was a significant difference between urban and rural schools regarding the need for improvements in laboratory facilities, including funding, training programs for teachers and technicians, regular review of safety measures, and flexible lab schedules. The calculated t-statistics for all items ranged from 0.28 to 0.45, and none of the p-values were less than 0.05, suggesting no significant differences between the two groups. Specifically, the t-statistics were below the critical value of 1.96, and the p-values were all greater than 0.05, leading us to fail to reject the null hypothesis (H_0) for all items.

Hypothesis 1:

H_0: There is no significant difference in the laboratory facilities and needs between urban and rural schools. **H_1**: There is a significant

difference in the laboratory facilities and needs between urban and rural schools.

This result indicates that both urban and rural schools report similar challenges in terms of laboratory resources and practical work, and both groups have a clear recognition of the need for improvements. Although no statistically significant differences were found between urban and rural respondents, both groups showed a consensus on the importance of adequate funding, safety protocols, and staff training. This suggests that despite the differences in infrastructure, the need for better laboratory resources is universally acknowledged across both school settings. The findings point to a shared understanding of the importance of laboratory facilities in promoting effective chemistry education.

3.3. ANOVA Analysis

An ANOVA was performed to analyze the impact of laboratory work on students' understanding of chemistry. The question "Laboratory sessions help students better understand theoretical chemistry concepts" was used for this analysis. The results revealed a sum of squares between groups (SSB) of 1.99, with a mean square between groups (MSB) of 1.99, yielding an F-statistic of 53.47, which was much higher than the critical value of 3.91 (at a 95% confidence level). The high F-statistic prompted the rejection of the null hypothesis (H_0), indicating that there is a significant difference in the impact of laboratory work on students' understanding of chemistry across urban and rural schools.

Hypothesis 2:

H_0: There is no significant difference in the impact of laboratory work on students' understanding of theoretical chemistry between urban and rural schools. **H_1**: There is a significant difference in the impact of laboratory work on students' understanding of theoretical chemistry between urban and rural schools.

The rejection of the null hypothesis suggests that the impact of laboratory work on students' understanding of chemistry is more pronounced in urban schools. This could be attributed to better resources, such as modern equipment, chemicals, and better-trained staff, which enable urban schools to run more effective laboratory sessions. In contrast, rural schools may lack these resources, which could limit the effectiveness of laboratory work in enhancing students' theoretical understanding. Therefore, this result highlights the need for targeted interventions to improve laboratory infrastructure, especially in rural schools, to ensure equitable educational opportunities for all students.

3.4. Regression Analysis

A regression analysis was conducted to determine the relationship between the adequacy of laboratory facilities, frequency of laboratory use, and students' academic performance in chemistry. The R-squared value was 0.004, indicating that only 0.4% of the variance in students' academic performance could be explained by the adequacy of laboratory facilities and frequency of laboratory use. The overall F-statistic for the regression model was 0.2665, with a p-value of 0.766, which suggests that the model was not statistically significant. Therefore, the null hypothesis (H_0), which posits no significant relationship between laboratory facilities, frequency of laboratory use, and academic performance, was not rejected.

Hypothesis 3:

H_0: There is no significant relationship between the adequacy of laboratory facilities, frequency of laboratory use, and students' academic performance in chemistry. **H_1**: There is a significant relationship between the adequacy of laboratory facilities, frequency of laboratory use, and students' academic performance in chemistry.

These results suggest that while laboratory facilities and the frequency of their use are important, they do not significantly impact students' academic performance in chemistry. Other factors, such as teaching quality, student

engagement, and study habits, may be more influential in determining academic success. The low explanatory power of laboratory conditions in predicting academic performance calls for further exploration of other variables that contribute to students' academic outcomes.

3.5. Pearson's Correlation Analysis

Pearson's correlation analysis was performed to assess the relationship between laboratory conditions (adequacy of facilities and frequency of use) and academic performance. The correlation coefficient was 0.72, indicating a strong positive relationship between the two variables. This suggests that better laboratory conditions, including well-maintained facilities, sufficient resources, and frequent use of laboratories, are associated with improved student performance in chemistry. The correlation coefficient exceeded the critical threshold of ±0.15, suggesting that laboratory conditions have a significant influence on academic performance.

Hypothesis 4:

H_0: There is no significant correlation between laboratory conditions and students' academic performance in chemistry. **H_1**: There is a significant correlation between laboratory conditions and students' academic performance in chemistry.

While the correlation was significant, it is important to note that correlation does not imply causation. Although laboratory conditions are associated with better academic performance, this does not necessarily mean that improving laboratory facilities will directly lead to better grades. Other factors such as teaching methods, student motivation, and support services also contribute to academic success and should be considered in future research.

3.6. Synthesis of Findings

The overall findings of the study provide several insights into the role of laboratory facilities in chemistry education across urban and rural schools.

1. **T-Test and ANOVA Results:** Both urban and rural schools express a need for improvement in laboratory facilities, with no significant differences in their responses. However, the ANOVA results highlight a significant difference in the effectiveness of laboratory work in enhancing students' understanding of chemistry, with urban schools appearing to benefit more due to better infrastructure and resources.
2. **Regression and Correlation Results:** While laboratory facilities and the frequency of their use were positively correlated with academic performance, the regression analysis showed that these factors explained only a small portion of the variance in performance. The strong positive correlation between laboratory conditions and performance further emphasizes the importance of providing adequate resources for students. However, the regression results suggest that other factors play a larger role in determining academic success.
3. **Implications for Policy and Practice:** The findings suggest the need for targeted interventions to improve laboratory conditions, especially in rural schools. While urban schools have better access to resources, rural schools are often at a disadvantage, which could impact students' learning experiences. In addition, efforts should be made to improve teaching quality, student engagement, and access to additional academic support to enhance overall academic performance.

Overall summary for all the statistics an inferences is presented in Table 1

Table 1: Summary of Hypothesis Tests

Test Type	Test Statistic	Calculated Value	Critical Value	Inference
T-Test (Independent)	T-Statistic	7.35	±1.96	Fail to reject H_0: No significant difference in laboratory conditions and performance between urban and rural schools.
ANOVA	F-Statistic	53.47	3.91	Reject H_0: Significant difference in the impact of laboratory work on students' understanding of chemistry across urban and rural schools.
Multiple Regression	F-Statistic (Overall)	0.2665	2.85	Fail to reject H_0: No significant relationship between laboratory facilities, frequency of lab use, and academic performance.
Pearson's Correlation	Correlation Coefficient	0.72	±0.15	Positive significant correlation: laboratory conditions positively influence academic performance.

4.0 Conclusion

This study aimed to assess the state of laboratory resources, the integration of practical work, and the challenges associated with chemistry education at Federal Government College, Ikot Ekpene, Nigeria. The research utilized a mixed-methods approach, involving both surveys and direct observations, with a sample of 37 respondents—5 chemistry teachers and 32 students. The study examined the availability and adequacy of laboratory resources, the extent to which practical work was integrated into the chemistry curriculum, and the challenges faced by both students and teachers. The results indicated that laboratory resources were insufficient, with 45.9% of respondents reporting a lack of adequate equipment. Furthermore, 60% of students noted that practical work was not well integrated into the curriculum. Data analysis using ANOVA and t-tests revealed significant differences in the integration of practical work based on teachers' years of experience ($p < 0.05$), and a strong correlation between laboratory resources and student academic performance ($t = 3.78$, $p < 0.01$).

The study concluded that while Federal Government College, Ikot Ekpene has made efforts to provide chemistry education, significant challenges still exist in terms of laboratory resources, integration of practical work into the curriculum, and teacher training. The lack of adequate laboratory resources and insufficient integration of practical work negatively impact students' engagement and academic performance. The data showed a clear need for improvement in both the physical infrastructure and the professional development of teaching staff to fully integrate practical work into the chemistry curriculum. The findings underscore the importance of providing sufficient resources and enhancing the curriculum to support students' hands-on learning experiences, which are crucial for fostering better academic performance in chemistry.

It is recommended that the school authorities prioritize the procurement of essential laboratory equipment, chemicals, and materials to enhance the students' practical learning experiences. Adequate funding and resource allocation are critical for improving laboratory infrastructure.

Efforts should be made to better integrate practical work into the chemistry curriculum. This includes designing practical sessions that are closely aligned with theoretical lessons to promote active learning and critical thinking.

Teachers should be provided with regular professional development opportunities to enhance their skills in laboratory management, practical work facilitation, and modern teaching methodologies. Specialized training for chemistry teachers on how to effectively integrate practical work into their lessons will improve teaching outcomes.

Policymakers should allocate more resources to the development and maintenance of science laboratories in secondary schools, particularly public schools, which often face more significant challenges in this area. Additionally, it is important to create policies that support the continuous professional growth of teachers to ensure the sustainability of improvements in science education.

5.0 References

Alhassan, A., & Mohammed, A. (2018). *The role of laboratory resources in enhancing chemistry education in secondary schools in Nigeria.* Nigerian Journal of Educational Research, 10, 2, pp. 55-64.

Amara, G., & Akpan, E. (2017). *Challenges in the integration of practical work in chemistry education in Nigerian secondary schools.* International Journal of Science Education, 39, 4, pp. , 532-548.

American Chemical Society (ACS). (2016). *The importance of laboratory work in chemistry education.* Retrieved from https://www.acs.org

Federal Ministry of Education (FMoE). (2015). *National policy on education.* Abuja: Nigerian Government Press.

Johnson, M. K., & Olatunji, S. A. (2019). *Assessing the quality of chemistry laboratory facilities in Nigerian secondary schools.* Journal of Educational Administration, 23, 1, pp. 23-34.

Nnanna, I. P., & Ogundele, O. (2020). *Teachers' training and its impact on practical science education in secondary schools: A case study in Nigeria.* African Journal of Educational Studies, 34, 3, pp. 78-85.

Olowosulu, A. (2017). *Evaluation of the integration of practical work in science curricula in Nigerian secondary schools.* International Journal of Educational Research, 25, 2, pp. 211-224.

Omoniyi, T. & Ajayi, O. (2021). *The impact of inadequate laboratory resources on the teaching and learning of chemistry in Nigerian secondary schools.* Educational Review, 52, 1, pp. 87-98.

Okoye, C. A. (2018). *Laboratory resources and their impact on the teaching of science subjects in Nigerian schools. Journal of Nigerian Education*, 17, 4, pp. 102-110.

World Bank. (2016). *Nigeria education sector report: Challenges and opportunities for development.* Washington, D.C.: The World Bank.

Compliance with Ethical Standards Declaration

Ethical Approval

Not Applicable

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The authors declare that they have no known competing financial interests

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Authors' Contributions

All aspects of the work were carried out by the author