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Research Article

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Laboratory Resources Availability, Accessibility and Utilization as Correlate of Chemistry Students' Academic Achievement

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ABSTRACT

The research work is a correlational design on laboratory resource availability, accessibility, utilization and chemistry students' academic performance in public senior secondary schools in Ahoada West Local Government Area in Rivers State, Nigeria. The study had three research questions and corresponding three null hypotheses formulated at 0.05 level of significance. 100 chemistry students in SSII and SSIII were randomly selected to give this sample size for this study. The students were subjected to researcher self-structured questionnaire whose reliability coefficient 0.76 was used to collect the responses which was analyzed using Pearson Product Moment correlation statistics. The findings showed that all three laboratory resource factors – availability, accessibility and utilization had significant relationship with chemistry students' academic performance, with accessibility standing out as the strongest predictor of performance outcome for the chemistry students in public senior secondary schools in Ahoada west local government area in Rivers State, Nigeria. Hence one of the recommendations was that Government and well-meaning citizens should invest in improving the educational system through funding to providing of science laboratory infrastructure and equipment and training of teachers to enable them engage students in practical exercises as is demanded by the subject chemistry being experimental in nature.

Keywords: laboratory, availability, accessibility, utilization, chemistry

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INTRODUCTION

The science laboratory is the scientists' work place for both research work, teaching and learning in science. Nbina (2013) stated that "the Science laboratory is an instructional facility used by the teacher to make his students learn about science and to know how scientists discover the world around them". Science laboratory offers students the opportunity to engage in scientific inquiry and to equip the learner to develop critical thinking ability essential for scientific problem solving (Adeyemo & Omoniyi, 2016). Furthermore, laboratory has the ability to develop in the learner science practical skills

such as experimentation, data analysis and interpretation of data (Akpan, Udoh & Effiong, 2017). The laboratory learning has the ability to equip the learner with knowledge, skills to engage in scientific inquiring and problem solving. Additionally, science laboratory experiences are capable of instilling self-confidence in the learner being that through engagement with learning objects, the learning is given vivid explanations of the meaning of the subject matter of concern. According to Al-Rabaani (2014) effective laboratory environment is essential for impressive inquiry/discovery activities.

This implies that provision of adequate Science laboratory facilities and equipment are essential to Science teaching and learning. The science laboratory is crucial in the learning of science in many ways, first for the gain of scientific knowledge, acquisition of science process skills and development of inquiry and problem-solving abilities added to a disciplined mind. Hence it will be inappropriate if science is practiced in the absence of the science laboratory. The laboratory is a place for scientific investigation whereby the scientific processes are brought into actions and the aim of discovery of the natural world is achieved by its practices.

For science to be effectively taught and learned, there has to be a standard laboratory in place, such that has in place the essential equipment and facilities use for practicing science for any particular stage of learning in view. For the laboratory to be useful in doing this works there had to be resource available and accessible for utilization by both the teacher and learner. Science laboratory resources can be categorized broadly as human resources including the teacher and the laboratory staff e.g. laboratory technician, laboratory assistant and the material resources including facilities and equipment as well as reagents/chemicals, species which in some cases are animals and plants used for scientific studies. Laboratory resources, including equipment, materials, and facilities are integral components of chemistry education, providing students with hands-on learning experiences that complement theoretical instruction (Sanger, 2016).

Hands on minds on laboratory experiences allow students to engage in authentic scientific inquiring conduct experiment and apply theoretical concept in practice context. Adeyemo & Omoniuyi (2016), emphasize that hands-on experiences in science laboratory setting enable students to explore chemical phenomena, allowing them to develop a deeper understanding of fundamental principles. When the teacher engages students in practical work, it will definitely help students not only to apply theoretical knowledge but also develop critical thinking and problem-solving skills essential for successful learning in chemistry. More so, laboratory gives the students' experiences in the learning necessary for any particular concept in such a manner that permits academic achievement and retention of what is learned (Abdullahi & Ademoroti, 2018). Moreover, laboratory practical provides students the opportunity to apply theoretical knowledge to real-world scenarios, bridging the gap between classroom instruction and practical application (Abdullahi & Ademoroti, 2018). Practical works also promotes collaborative learning whereby students learn in groups and share their experiences and as well apply the same to scientific investigations in which process they are also able to develop problem-solving skills and gain confidence in their ability to navigate complex scientific

concepts and phenomena (Akpan, et al., 2017). Theories, laws, postulates etc. are products of science reached through scientific inquiring and for to verify or understand them, the learner needs to do science in practical manner. Other times practical are expected to expand inquiring and to broaden the structural understanding of chemical principle, foster critical thinking skills, solve problems and create scientific literacy. According to Akpan et al. (2017), laboratory practices offers opportunities for students to develop practical skills such as experimental designing, data analysis and safety protocols. The knowledge gained through practice are as well retained more than that whereby when the knowledge come through theoretical learning. Laboratory learning that utilize laboratory resources foster meaningful learning experience and enhance students' academic performance of chemistry (Olaleye & Ogunkola, 2018). Though laboratory learning is essential, an effective laboratory environment is crucial in all. Effective laboratory environment is a necessity and encourages students to gain knowledge and acquire various relevant skills vital to science learning in particular. It is also worth noting that the laboratory can also be impressively effective in inquiry/discovery learning if the laboratory facilities and equipment are available for utilization for the teaching – learning process. The laboratory may be well-equipped but because it is not just furniture, so could only make meaning when properly managed for the teacher and learner to have access to it. This boils down to the fact that availability, accessibility and utilization of science laboratory encompass what the teacher and learner need to maximize science teaching and learning. Researches have shown a possible correlation between laboratory resource availability, accessibility, utilization, and students' academic achievement in chemistry. Access to well-equipped laboratory and effective utilization practices have been associated with improve students' engagement and achievement in chemistry examination (Adullahi & Ademoroti, 2018). On the contrary, lack of laboratory facilities and limited access to laboratory resources have limited students in their academic achievement and associated learning benefits. Inadequate laboratory facilities and limited access to laboratory resources have been identified as a significant barrier militating against students' success in chemistry (Ibrahim & Adeleke, 2015). Chemistry education curriculum for the secondary school level had been design to help students with gain essential knowledge and skills. To this end, the goal of science education is to develop skills in the learner and to enable him apply it in everyday life. National policy on education (FRN, 2014) includes science to be taught at all levels of the educational system. The senior secondary school science learning is broader to equip the learner for future activities in the field of science and technology.

Some of the science laboratory resource related challenges in public secondary school on Nigeria include: limited funding, outdated equipment, lack of essential laboratory equipment, poorly equipped laboratory, dilapidated laboratory structures, lack of laboratory structure, multi-purpose laboratory space, insufficient laboratory space, little or no training in handling of laboratory materials, no safety training as well, limited funding may result in outdate equipment, inadequate facilities and lack of essential laboratory material & equipment.(Ibrahim & Adeleke, 2015). Meanwhile educators, school inspectors and stakeholders can make deliberate effort to enhance laboratory resources availability, accessibility and utilization for meaningful science learning experiences for students in science education.

Statement of the problem

Despite the recognition that had been given to the importance of well-equipped science laboratory in the teaching and learning of particularly science of chemistry, there is still a very notable discrepancy that needs to be bridge. One of such gaps is in the limited research specifically to address the relationship between laboratory resources availability, accessibility and utilization and academic performance in Nigerian educational context directly that related to the science subject. Existing studies have shown positive relationship between well-equipped science laboratory and improved students' academic achievement in chemistry (Abdullahi & Ademoroti, 2018). However, these studies have not considered deeply what specific methods through which laboratory resources utilization influence academic performance, particularly in Nigerian educational context.

Moreover, persistent challenges such as lack of laboratory facilities, outdated equipment, and limited access to resources have posed significant barriers to effective teaching and learning particularly in the science of chemistry that otherwise would have yielded outstanding performance in the students.

Therefore, this research sought to investigate the relationship between science laboratory resources availability, accessibility, utilization and chemistry students' academic performance in Ahoada West Public Senior Secondary Schools in Ahoada West in Rivers State, Nigeria.

Research Questions

1. What is the relationship between laboratory resources availability and chemistry students' academic performance in Public Senior Secondary Schools in Ahoada West Local Government Area, Rivers State?
2. What is the relationship between laboratory resources accessibility and chemistry students' academic

performance in Public Senior Secondary Schools in Ahoada West Local Government Area, Rivers State?

3. What is the relationship between laboratory resources utilization and chemistry students' academic performance in Public Senior Secondary Schools in Ahoada West Local Government Area, Rivers State?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

- 1 There is no significant relationship between laboratory resources availability and chemistry students' academic performance in Public Senior Secondary Schools in Ahoada West Local Government Area, Rivers State.
- 2 There is no significant relationship between laboratory resources availability and chemistry students' academic performance in Public Senior Secondary Schools in Ahoada West Local Government Area, Rivers State.
- 3 There is no significant relationship between laboratory resources availability and chemistry students' academic performance in Public Senior Secondary Schools in Ahoada West Local Government Area, Rivers State

METHODOLOGY

The study adopted a correlational study design to examine the laboratory resource availability, accessibility, utilization as correlate of chemistry students' academic performance in Public Senior Secondary Schools in Ahoada West Local Government Area of Rivers State in Nigeria. The sample of the study comprises 100 public senior secondary schools chemistry students randomly selected from this area. The instrument used for collection of data was a researcher structured questionnaire tagged, questionnaire on laboratory resource availability, accessibility, utilization and academic performance (QLRAAUAP). The questionnaire was validated by science education lecturer from Ignatius Ajuru University of Education in Rivers State, Nigeria. Test-retest was used and calculated using Pearson Product moment to give the coefficient index 0.78. Data collected by this instrument was analyzed Pearson Product moment correlation using a two-tailed significant test ($p < 0.05$) to provide reliability insight to the data.

RESULTS

Research Question 1: What is the relationship between laboratory resources availability and chemistry students'

academic performance in Public Senior Secondary Schools in Ahoada West Local Government Area, Rivers State?

Hypothesis 1: There is no significant relationship between laboratory resources availability and chemistry students' academic performance in Public Senior Secondary Schools in Ahoada West Local Government Area, Rivers State.

The Pearson correlation coefficient between total laboratory resource availability and students' performance score is 0.421, indicating a moderate positive correlation. This means that as resource availability increases (Table 1). The performance of students equally increases. The p-value of .000 indicates that the relationship is statistically significant.

Table 1: Correlation between laboratory resource availability and chemistry students' academic performance in public senior secondary schools in Ahoada West local government area, Rivers State.

		Availability	Score
Total availability	Pearson Correlation	1	0.421**
	Sig. (2-tailed)		.000
	N	100	100
Score	Pearson Correlation	0.421**	1
	Sig. (2-tailed)	0.000	
	N	100	100

Research Question 2: What is the relationship between laboratory resources availability and chemistry students' academic performance in Public Senior Secondary Schools in Ahoada West Local Government Area, Rivers State?

Hypothesis 2: There is no significant relationship between laboratory resources accessibility and chemistry students' academic performance in Public Senior Secondary Schools in Ahoada West Local Government Area, Rivers State.

The Pearson correlation coefficient between total laboratory resource accessibility and students' performance score is 0.818, which is a strong positive correlation. This suggests that the greater resource accessibility the higher the average performance. The performance of students equally increases (Table 2). The p-value of .003 is statistically significant, indicating that this strong correlation is unlikely due to chance.

Table 2: Correlation between laboratory resource accessibility and chemistry students' academic performance in public senior secondary schools in Ahoada West local government area, Rivers State.

		Accessibility	Score
Total accessibility	Pearson Correlation	1	0.818**
	Sig. (2-tailed)		0.003
	N	100	100
Score	Pearson Correlation	0.818**	1
	Sig. (2-tailed)	0.003	
	N	100	100

Research Question 3: What is the relationship between laboratory resources utilization and chemistry students' academic performance in Public Senior Secondary Schools in Ahoada West Local Government Area, Rivers State?

Hypothesis 3: There is no significant relationship between laboratory resources utilization and chemistry students' academic performance in Public Senior Secondary Schools in Ahoada West Local Government Area, Rivers State.

The Pearson correlation coefficient between total laboratory resource utilization and students' performance score is 0.559, indicating a moderate positive correlation (Table 3). This means that better utilization of resource is associated with higher average performance score of students. The p-value of .013 indicates that the correlation is statistically significant.

Table 3: Correlation between laboratory resource utilization and chemistry students' academic performance in public senior secondary schools in Ahoada West local government area, Rivers State.

		Utilization	Score
Total utilization	Pearson Correlation	1	0.559**
	Sig. (2-tailed)		0.013
	N	100	100
Score	Pearson Correlation	0.559**	1
	Sig. (2-tailed)	.013	
	N	100	100

DISCUSSION

The correlation analyses provide valuable insight into how resource availability, accessibility and utilization impact chemistry students' performance. Each of the variables indicating difference impact on the performance, with accessibility leading as the most significant predictor of the positive impact on the students' performance in the learning of chemistry. There are previous studies by various researches that could be used to buttress these findings. Resource availability and performance shows ($r = .421$, $p = .000$) indicating moderate correlation between resource availability and students' performance in chemistry and this is in line with the study of Abidoye, Adebisi and Rihanat (2022) who in their study found significant influence on the availability of laboratory facility on students' academic performance in upper basic schools. Contrary to this study is the finding of Norona (2021) in a comparison analysis on the status of laboratory resources and science process skills of grade II learners firstly revealed variation in the number of available and non-available laboratory resources which difference was significant and secondly that availability and utilization of science laboratory resources when associated with the grade II integrated science

process skills mastery levels showed no significant relationship. In Pareek (2019) the finding had it that the non-availability of laboratory resources was not directly the measure of students' academic performance.

Resource accessibility and performance ($r = .818$, $p = .003$). This shows strong positive correlation and that emphasizes that the role of accessibility is even more important in science laboratory learning. In the study of Pareek (2019) the finding revealed that only few teachers (25%) have access to laboratory resources and that was likely the cause for poor scientific literacy.

Laboratory resource utilization and academic performance ($r = 0.559$, $p = 0.013$). This moderate correlation between utilization and performance suggest that effective and efficient science learning rely on the use of laboratory resources. In support of this study is the separate research works of Adeleye, and Danjuma (2015) and Musah and Umar, (2017) who showed that utilization have positive correlation with academic achievement and not lack of equipment per se. However, Etiubon and Udoh (2020), holds that both non-availability and non-utilization hinder achievement of laboratory practical and in extension academic performance.

The second dimension to availability, accessibility and utilization is that of management. This implies that equipment availability accessibility and utilization further depend on number of factors such the number of each of this laboratory resource factors. Ngera and Echaune (2023) studies some of these management factors and saw correlation between numbers of times students learned in the laboratory as positive for students who had greater times for such learning. Also number of student who shared equipment had negative correlation in the examination and number time students went to the laboratory was also negative effect in examination so concluded that management of science laboratory resources has significant predictor to students' academic achievement.

Recommendations

- (a) Laboratory learning is an integral part of science learning hence the concern authority should see to it that every school is provided with standard laboratory for adequate science teaching-learning activities.
- (b) School science laboratory should be provided in every school by the government and school authority should create avenue for learning in the laboratory by allowing even the student access to carry out project on science in the laboratory under the supervision of laboratory staff or the science teacher.
- (c) Science teachers should regularly conduct practical classes that will be carried out using school laboratory resources so as to take advantage of such

facilities where they are available for learning in science and not to shy away from such responsibilities.

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