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INVESTIGATING THE ROLE OF LABORATORY IN THE DEVELOPMENT OF CHEMISTRY KNOWLEDGE IN SECONDARY SCHOOLS IN IMO STATE

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Abstract

The study aimed at investigating the role of chemistry laboratory in the development of knowledge of chemistry in secondary schools in Owerri Municipal Council in Imo State, Nigeria. Three specified objectives and questions were posed to guide the study, and a researcher's constructed questionnaire was used to elicit information from the respondents. Collection of data was achieved through random sampling of five (5) out of ten (10) governments owned secondary schools in Owerri Municipal Council of Imo State. A sample of one hundred and fifty- five students responded to the questionnaire which represents five percent (5%) of the entire population. The structure of the questionnaire was the Likert model. A decision for acceptance was based on the mean of 2.50 and above, while mean below 2.50 was for rejection. Mean and standard deviation were used for data analysis. The findings obtained from the research work revealed that inadequate and ill-equipped chemistry laboratories, insufficient chemistry practical for students were some of the factors that impacted negatively on students' knowledge of chemistry in senior secondary schools in Imo State. As a way of recommendation, government and school authorities should ensure adequate provision of laboratory equipment and facilities so as to improve the conduction of practical in chemistry at the senior secondary school level.

Introduction

The chemistry laboratory plays a fundamental and distinctive role in science and chemistry education. Laboratory experiments are used to practically demonstrate theoretical principles and validate empirical laws taught in chemistry classroom. The chemistry laboratory avails the students the opportunity to come in contact with variety of specialized equipment. The chemistry teacher, in order to sustain the interest of the students and enhance their performance, should utilize latest instructional techniques and prepare the students adequately on the usage of equipment in the laboratory. Many research papers and doctoral dissertations that investigated the unique role played by science laboratory in science education have been published, but literature on the role of science laboratory in development of chemistry knowledge in Owerri Municipal Council has not been written, which is what the present work attempted to provide.

Efe & Abamba (2023) studied the effect of laboratory methods on students' acquisition of science process skills among senior secondary students of chemistry. They utilized pre-test, post-test and control group design for the study, using three schools for experimental group and three schools for control group. The instruments for the study include chemistry practical ability test (CPAT) and chemistry process skill rating scale (CPSRS). The findings from the study revealed that laboratory method of instruction contributed about 74 % to students' acquisition of science process skills. Famuwagun (2024) investigated the improvement of senior secondary school students' performance in chemistry through laboratory-based teaching strategy using pre-test, and post-test design. The instrument for assessment was laboratory-based chemistry achievement test. The result showed that there was positive improvement in the performance of students taught with laboratory-based

teaching strategy compared with those taught with conventional methods. Aliyu & Talib (2019) discussed the benefits of integrating virtual laboratory in the teaching of chemistry, as some schools in Nigeria lacked laboratory personnel and facilities. Twizeyimana & Mugiraneza (2024) investigated science laboratory practices and students' attitudes in chemistry in public secondary schools in Rwanda, using 213 out of 735 population of participants from 4 public secondary schools in Ngoma district of Rwanda. The instrument for data collection was questionnaire and interview. The result showed that perceived laboratory practices were the determinants of students' motivation towards learning science subjects especially chemistry.

Blackburn et al. (2019) reported on the technological advancement of learning science, where year one chemistry students of the University of Leicester were exposed to simulation of common laboratory techniques and equipment before carrying out practical in the real laboratory environment. The result of this prior simulation showed an improvement in the students' confidence level, increased speed level and improvement of their assessment score from a mean of 67 % prior to simulation to 74 % after simulation. Kandamby (2019) carried out a research work on the effectiveness of laboratory practical for students learning by using questionnaire to find out what students learn from the practical by recalling learned materials from a sample of students. The result showed that the students remember observable aspects of practical work. It was also discovered that the students' active involvement in learning before the commencement of practical with the assistance of their instructor, observing of physical outcomes, while doing and searching additional information at the end through the internet have showed better results. Duban et al. (2019) investigated on classroom teachers' opinions on science laboratory practices. Interview technique involving individual semi-structured interviews with participants was used for the study. Data evaluation was by qualitative data analysis. The study revealed that materials were available and there were responsible laboratory teachers in the science laboratory. Vysakh et al. (2020) developed an instrument that characterized experimental self-efficacy (ESE) and the impact of pre-laboratory interventions such as exposure to virtual laboratory (VL) on ESE. and conceptual knowledge of students. The data analysis which was carried out using statistical tools like t-tests and dissimilarity matrices revealed the positive impact of VL in enhancing students' ESE. In the work of Alexsandar (2020), research has shown that students who engage in well-designed laboratory experiences develop problem-solving and critical thinking skills, as well as gain exposure to reactions, materials and equipment in a laboratory setting.

Statement of the Problem

Aspects of chemistry are abstract and practical demonstration of its concepts will not only help to facilitate the interest of the students, but will also assist them to gain mastery of the subject matter. A common observation, as at the time of the study, showed that some government owned secondary schools in Owerri Municipal Council of Imo State had three science laboratories for chemistry, physics and biology respectively; some had two, while some others had only one multipurpose science laboratory. This may imply that many students may not be exposed to practical work experience in some secondary schools in Owerri Municipal Council of Imo State. Inadequate laboratories and non-attendance to practicals create a gap between theory and practice, brings poor understanding of abstract concepts, which will lead to reduced motivation, and consequently poor performance in chemistry. It is on this premise that the researchers were motivated to carry out an investigation on the role of chemistry laboratory in the development of chemistry knowledge in secondary schools in Owerri Municipal Council of Imo State.

Purpose of Study:

This includes the following:

1. Investigate the extent the lack of chemistry laboratory equipment affects learning of chemistry in senior secondary schools in Imo State.
2. Determine the extent the teacher method during laboratory practical has affected the learning of chemistry in Owerri Municipal Council of Imo State, Nigeria
3. Ascertain the extent chemistry practical is done in secondary schools in Owerri Municipal Council of Imo State.

Research Questions

1. To what extent does lack of chemistry laboratory equipment affect learning of chemistry in senior secondary schools in Owerri Municipal Council of Imo State?
2. To what extent does teachers' factor affect the grasping of chemistry knowledge and skills among students in senior secondary school students in Owerri Municipal Council of Imo State?
3. To what extent are chemistry practical done in secondary schools in Owerri Municipal Council of Imo State?

Scope of Study

The study is delimited to government secondary schools in Owerri Municipal Council of Imo State, as well as the role of laboratory in the development of chemistry knowledge in secondary schools in Owerri Municipal Council of Imo State.

Methodology

The research is a descriptive survey designed to investigate the role of chemistry laboratory in the development of chemistry knowledge in secondary schools in Owerri Municipal Council of Imo State. The population of the study comprised of all the ten (10) government owned secondary schools in Owerri Municipal Council of Imo State, totaling three thousand, one hundred. Random sampling technique was used to select five (5) out of then (10) schools in the council. The sample size comprised of one hundred and fifty-five students, which is 5 % of the entire students' population within the council. The instrument for data collection was the researchers' designed questionnaire to elicit information on the role of chemistry laboratory in the development of chemistry knowledge in secondary schools in Owerri Municipal Council of Imo State. The questionnaire was validated by two experts, one from chemistry department, and the other from faculty of education, Alvan Ikoku Federal University of Education, Owerri, Imo State, Nigeria. One hundred and fifty-five copies of the questionnaire were distributed by the researchers to the students, and afterwards collected for analysis. Data analysis was achieved by using mean and standard deviation. The questionnaire was designed using the four-point Likert of strongly agree (4 points), agree (3 points), disagree (2 points) and strongly disagree (1 point). The decision rule stipulates that values obtained which were below 2.5 were rejected, while values of 2.5 and above were accepted.

Results

The results obtained were presented in Tables 1-3 as follows.

Research Question 1: To what extent does lack of equipment in chemistry laboratory affect learning of chemistry in senior secondary schools in Owerri Municipal Council of Imo State?

Table 1: Mean and standard deviation of students' responses to question 1

S/N	ITEMS	MEAN	STANDARD DEVIATION	REMARK
1	The inadequacy of laboratory equipment makes the study of chemistry uninteresting	3.07	0.7744	Accepted
2	The unavailability of laboratory equipment discourages students from learning chemistry	3.23	0.8827	Accepted
3	Lack of laboratory equipment makes the teaching and learning of chemistry difficult	2.87	1.0536	Accepted
4	The nature of chemistry laboratory in secondary schools makes students to develop interest in chemistry	3.01	0.9901	Accepted

From Table 1, the mean value for item 1 is 3.07 with standard deviation of 0.7744, mean value of item 2 is 3.23 with standard deviation of 0.8823, mean value for item 3 is 2.87 with standard deviation of 1.0536, and mean value of 3.01 with standard deviation of 0.9901 for item 4.

Research Question 2: To what extent does teaching methods adopted by the teachers affect learning of chemistry practical in senior secondary schools in Owerri Municipal Council of Imo State?

Table 2: Mean and standard deviation of students' responses to research question 2

S/N	ITEMS	MEAN	STANDARD DEVIATION	REMARK
1	Different teaching methods help to develop students' interest in chemistry practical	3.00	1.0690	Accepted
2	Teaching methods that are learner-centered are adopted by chemistry teachers	2.46	1.126	Rejected
3	Demonstration method of teaching chemistry allows students to learn faster	3.14	0.9345	Accepted
4	Inappropriate use of instructional materials by the teachers affects the performance of students in chemistry practical	2.49	1.0591	Rejected

In Table 1, the mean value for item 1 is 3.00 with standard deviation of 1.0690, mean value of item 2 is 2.46 with standard deviation of 1.1261, mean value for item 3 is 3.14 with standard deviation of 0.9345, and mean value of 2.49 with standard deviation of 1.0591 for item 4.

Research Question 3: To what extent are chemistry practical done in secondary schools in Owerri Municipal Council of Imo State?

Table 3: Mean and standard deviation of students' responses to question three (3)

S/N	ITEMS	MEAN	STANDARD DEVIATION	REMARK

1	Our chemistry teacher always makes use of chemistry laboratory for practical	2.24	11137	Rejected
2	There are not enough chemistry practical periods	3.30	0.7523	Accepted
3	Chemistry practicals are not regularly taught by the teacher and students	2.96	0.9560	Accepted
4	Our chemistry teacher only makes use of the chemistry laboratory close to the time of external examination	2.92	1.0291	Accepted

In Table 3, item 1 has a mean value of 2.24 with a standard deviation of1.1137, item 2 has a mean value of 3.30 with a standard deviation of 0.7523, item 3 has a mean value of 2.96 and a standard deviation of 0.9561, while item 4 has a mean value of 2.92 with a standard deviation of 1.0291.

Discussion of the Findings

The results from Tables 1-3 provides insight into the challenges faced in learning chemistry in senior secondary schools in Owerri Municipal Council of Imo State. From Table 1, all the items had mean values above 2.5, indicating that the students generally agreed that lack of laboratory equipment negatively impacted learning of chemistry. The highest mean value of 3.23 corresponds to the statement that the unavailability of laboratory equipment discouraged students from learning chemistry, showing strong agreement among students. The lowest mean value of 2.87 was still above 2.50, meaning that students acknowledged that lack of equipment makes teaching and learning difficult. The standard deviation values ranging from 0.7744 to 1.0536, indicate moderate variability in students' responses, which suggests a fair level of agreement with the issues under discussion. The findings of the present work are consistent with the work of Dike and Salisu (2015) which showed that inadequate laboratory facilities affected meaningful teaching and learning in schools and hindered academic performance of students. However, the difference is that while the work of Dike and Salisu (2015) focused on biology students in Zaria metropolis, Kaduna State, the present work was carried out among chemistry students in Owerri Municipal Council of Imo State, all in Nigeria. Besides the work of Caymaz (2021) took a different approach to study the knowledge and views of secondary school students in Kastamonu province Turkey, on laboratory safety, and found out that most of the students did not feel competent about laboratory safety. The work of Caymaz (2021) differed from the current study as it sought to find out the views and knowledge of secondary school students on laboratory safety, whereas the present research sought to find out how availability of laboratory facilities affects the acquisition of chemistry knowledge among secondary school students. Besides, there is difference in geographical location, as the work of Caymaz was done in Kastamonu province of Turkey, while the present work was done in Owerri Municipal Council of Imo State

From Table 2, the results showed mixed findings with regards to the teaching methods employed by the chemistry teachers. From item 1, students agreed that different teaching methods help to develop their interest in chemistry practicals. From item 2, students disagreed that learner-centered methods are commonly used by teachers, inferring that teaching remains largely teacher-centered. From item 3, students accepted that demonstration method helps them to learn faster, showing that they preferred hands-on methods. From item 4, students rejected the claim that teachers do not use instructional material properly, which implies that while some instructional materials are used, their effectiveness may not be maximized. Okwuduba and Okigbo (2018) also reviewed effective methods of teaching chemistry such as computer simulations, alternative teaching strategies and inquiry-based teaching. Besides, Olufunke (2020) assessed the role of laboratory facilities in the

preparation of functional science teachers in Ondo State. The similarity between this work and the present research is that both used questionnaire for data collection, and also used mean and standard deviation for data analysis. However, the difference is that while the work of Olufunke (2020) focused on preparation of functional teachers for science education, the research question in the present work narrowed it down to how teachers' method affects the acquisition of chemistry knowledge among secondary school students. There is also the difference in geographical location; whereas the work of Olufunke (2020) was carried out in Ondo State, the present work was carried out in Owerri Municipal Council of Imo State. The perception of teachers was that laboratory facilities played functional roles in the preparation of teachers for functional science education.

From Table 3, the responses are on the frequency of conducting chemistry practicals among the students. In item 1, students disagreed that their chemistry teachers always use the laboratory for practicals, which indicates that practical sessions are not conducted regularly. In item 2, students strongly agreed that periods allocated for practicals are not adequate, suggesting that practical work is not sufficient in the curriculum. In item 3, students accepted that practicals are not done regularly, thus buttressing the previous finding. In item 4, students agreed that teachers use the laboratory only close to the time of external examinations, indicating that practicals are not often incorporated into the regular learning activities. Seid et al. (2022) investigated the factors which affected the practice of laboratory work in secondary schools in Ethiopia. The findings are similar with the present work, as factors such as lack of financial resources, lack of time for practical work and students' lack of engagement in laboratory activities were the major constraints to the implementation of practical work in the school. However, the work of Seid et al. (2022) differed in geographical location, having carried out the work in Ethiopia, whereas the present work was carried out in Owerri Municipal Council of Imo State, Nigeria. Besides, Seid et al (2022) used questionnaires, observations and interviews as the method of data collection, while the present study made us of questionnaire to elicit information from the respondents. The respondents for the work of Seid et al. (2022) were both teachers and students, but the present work used only students as the respondents.

Conclusion

Based on the findings of the present work, the following conclusions were drawn.

1. The study revealed that lack of laboratory equipment negatively impacted students' interest and understanding of chemistry.
2. Learner-centered approaches were not widely adopted by teachers in secondary schools in Owerri Municipal Council of Imo State.
3. Chemistry practicals were not conducted frequently, with many schools limiting laboratory sessions to periods close to external examinations, which contributed to poor practical skills and limited engagement in the learning of chemistry.

Recommendations

1. The government, school administrators, and relevant stakeholders in chemistry education should allocate resources for equipping chemistry laboratories with modern apparatus and chemicals.
2. Teachers should incorporate inquiry-based learning, problem-solving approaches and hands-on experiments to actively engage students in chemistry practicals.
3. Schools should integrate practical sessions into regular classroom teaching rather than limiting them to the period of external examinations.
4. Education policy makers should review the secondary school chemistry curriculum to emphasize practical-based learning and ensure adequate laboratory exposure for students.

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