RE-APPRAISAL OF AVAILABILITY AND UTILIZATION OF LABORATORIES FOR TEACHING AND LEARNING OF CHEMISTRY IN COLLEGES OF EDUCATION, NORTH-EASTERN NIGERIA

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ABSTRACT

This study investigated the availability and utilization of laboratories in the teaching and learning of chemistry in Colleges of Education, North-Eastern Nigeria. The study was guided by three research questions. The study adopted the survey research design on a sample of eight-nine (89) chemistry lecturers of Colleges of Education in North-Eastern Nigeria. A validated questionnaire tagged: Availability and Utilization of Chemistry Laboratory Facilities (AUCLF) with a reliability index of 0.80 was used for data collection. The study revealed that laboratory facilities and accessories had means within 3.04 -3.88 and 2.48 -3.00 on a scale of 4.00 for availability and utilization tests respectively; indicating on the average that they are within the moderate level. The study enumerated lack of finance resulting in epileptic power and material supply, poor working conditions, lack of incentive, culture and poor students` attitude to practical as some of the challenges. Finally, the study suggested provision of the stable and steady facilities, adequate training of teachers in the use and maintenance of lab equipment, payment of improved emolument and enhanced hazard allowance to staff, seminars/symposia on the use, safety and role of laboratories in science and technology based courses for students as solutions.

Keywords: Laboratory, Effective use, Teaching and Learning, Chemistry, Colleges of Education

INTRODUCTION

Laboratories represent one of the stands in the tripod (teacher, students and instructional aid (lab) of teaching and learning in the sciences. Laboratory based learning occurs in the laboratory and uses practical experiments to develop students analytical and design skills, data collection, critical and technical capability, problem-solving skills and reporting ability. Its roles in science and technology in general and chemistry in particular are intertwined and cannot be undermined. Teaching and learning in the sciences without the laboratory practice is tantamount to buying a pig in a poke.

Laboratory has been an important means of institutions in science since late 19th Century in the high school chemistry in the 1880s. After the first world war, rapid need for scientific knowledge prompted the use of laboratory as a main means of illustrating and confirming information previously learnt in a lecture or textbooks. The education reforms in the 1960s in many countries made labs the core citadel of engaging students in investigation, discoveries, inquiries and problem solving activities for technological development (Lowe, 2015). According to Patricia (2018), laboratories were considered paramount because they provided trainings in observations, applied detailed information and aroused students' interests which are attributes still acceptable till date.

Laboratory teaching provides first-hand experience in observation and manipulation of the materials of science which assist in developing, understanding and appreciating scientific concepts. Tobin (1990), for example wrote that Laboratory activities appeal as a way of allowing students to learn with understanding and at the same time engage in the process of constructing knowledge by doing

science. It enhances retention in learning and skill development through hands-on experience. Patricia (2018) averred that teaching using laboratories is used to develop skills necessary for advanced study and research which plays a central role in science education.

Laboratories have long been regarded as an important component in science education (Kwot, 2015). Science educators have often stressed that more learning takes place thanks to laboratory act. Hofstein (2017) declared that Students gain direct experience by conducting experiments in laboratories positive students' attitudes and achievements to science education evolve through laboratory teaching. Hofstein (2004) attested to the fact that laboratory use improves students' ability in cognitive, affective and psychomotor domains. International Council for Science [ICSU] (2011) advanced that laboratory practice improves students` ability, while Cullin (2017) posited that laboratory practice fills the gap between theory and practice.

One of the main objectives of science teaching is to train individuals who will be able to adapt to rapidly changing and developing age and benefit from the latest technological innovations (Hancer *et al*, 2003). The aims of the laboratory are therefore, a subset of the overall aim of science and technology and includes among others are to provide students with conceptual and theoretical knowledge which helps to increase scientific knowledge and develop practical competence that help students to relate and reinforce theoretical concepts taught in the classroom.
Bennet (2003) as reported in Hofstein (2017) enumerated the traditional objectives of the laboratory as follows:

1. Understanding of scientific concepts - for example, hypothesis, theoretical model, taxonomic category
2. To arouse Interest and motive learners
3. To create positive attitudinal adjustment towards science for example, curiosity, interest, risk taking, objectivity, precision, confidence, perseverance, satisfaction, responsibility, consensus, collaboration, and liking science
4. To develop scientific practical skills - manipulative, inquiry, investigative, organizational, communicative and problem solving abilities
5. To develop cognitive abilities - critical thinking, problem solving, application, analysis and synthesis among others.

Teaching and learning using laboratories have also been known by researchers to have some advantages which some opined out-weigh other methods. Patricia (2018) opines that laboratory teaching assumes that first-hand experience in observation and manipulation of the materials of science is superior to other methods of developing understanding and appreciation. The supremacy of the laboratory is anchored in three stands of the tripod that holds the teaching and learning of sciences and chemistry in particular. These are:

1. The competence and capacity of the teacher to effectively teach and use the lab activities to entice and arouse students` attention and interest;
2. The attitude of the students towards the practical. This will also largely depend on the students` desire to learn given to right environment and
3. The state of the laboratory. Most laboratories are only a caricature of what they represent. Most of the basic equipment, reagents/chemical, apparatus, facilities/accessories are lacking to provide the conducive environment for its effective use and as such defective in both content and context.

The laboratory aspect of education structure is often neglected and relegated by government and school authorities at the expense of the students and national development. This lackadaisical atti-

tude towards research and teaching laboratories have resulted in the ever expanding gap between input and outcome of students being graduated at the end of their study periods. Olufunmilayo (2018) declared that there is much inconsistencies between the formal chemistry curriculum and the present day market and industrial demands; chemistry practical provides a formidable bridge between the two. Ayas *et al*., (2002) submitted that lack of laboratory facilities prevents students from learning at desired level resulting in what Cuban (2015) describes as "*productivity paradox*" and (Polák, 2017) explains that the advancement of technology is not matched with proportional increases the productivity of learning.

The assertion above constitutes a gap in the efficacy of laboratory and its use which calls for the present study to enable data be gathered on the availability of lab and lab equipment, extent of utilization and impediments to the effective utilization of chemistry laboratories in Colleges of Education in North-Eastern Nigeria. However, laboratories have been credited with the following merits to both staff and students:

1. Prompt generation of highly reliable data for inferences, decision making, and policy formulation;
2. Laboratory practical makes teaching enjoyable and easier,
3. It provides permanence in knowledge in learned subjects in students (Nil, 2019).

In spite the popularity enjoyed by the use of lab for teaching/learning, the method suffers some draw -backs that are sources of concern and discouragement to most teachers and students alike. Some of the blights could as well be reasons for underhanded treatment the labs suffer from both school authorities and government or its agencies. Some of the blights are:

1. High Risk: The lab is prone to a variant of hazards that are dangerous to both man and environment; whose effects could be acute or chronic. This is a huge source of discouragement to both staff and students. Otto (2021) lists laboratory hazards as including poisons, infection agents, flammable, explosive, radioactive agents, moving machines, extreme temperature, lasers, strong magnetic fields or high voltage,
2. Expensive: Equipping, running and maintaining a laboratory require substantial amount of money. This often creates rift between the staff in the lab and their superiors whose responsibility it is to fund the labs resulting in either total neglect or haphazard treatment of lab requests.
3. Laboratory practical might be complex and time consuming. Most students find this rather problematic and take to skipping such practical classes.

From the forgoing, it should be mentioned that safety precautions are very vital and the above hazard risk can be mitigated in a number of the following ways:

1. Conspicuous display of hazard warning signs,
2. Use of support tools such as nose/face masks, googles, hand gloves, lab coat,
3. Adopting standard operating procedures (SOPs),
4. Ensuring safe working environment and
5. Increased supervision.

Some researchers have begun to question the efficacy of the lab as no significant difference has been recorded in terms of its use in comparison to ordinary lecture room experience. They opined the results are not self-evident as student graduates in chemistry do not showcase the proficiency required of them. Moreover, training through laboratory practical is often one out of the very numerous courses a student undertake. In the present scenario of dilapidating and dwindling educational fortunes where laboratories are either mere physical structures with little or no basic infrastructures to make them functional as they should. This is beside the dearth of qualified and competent hands to run labs and conduct practical classes. There will certainly be a deviation from productivity ideality.

This study is therefore, to provide perspectives on the existing gap the previous researches that have not taken into consideration whether or not laboratories in our institutions are well positioned in terms of material and manpower requirement to deliver on their mandates. This appraisal is intended to collate data of functionality and viability of the labs, level of their utilization and the likely challenges confronting their utilization through structured questionnaires with a view to proffering solutions that will improve lab efficiency.

Statement of the Problem

The role of the laboratories in the teaching and learning of chemistry education cannot be over emphasized. The laboratories are the engine rooms of compounding students with resounding knowledge, proficiently skillful in handling chemistry materials, objective, efficient and eminently qualified in result analysis, presentation and reporting. Training to acquire these feats are only possible with the right working tool, a functional laboratory.

Practical classes chemistry in most of our institutions of learning today have moved to surrogate or make-shift laboratories where practical experiments are only "taught" and explained on the chalk board instead of using laboratory apparatus/materials such as test tubes, burettes, spectrophotometers etc. This is largely due to absolute absence of these basics and/or inability of the teacher to work with the materials. The result of this aberration is productivity paradox where results do not march the training and students not being able to demonstrate adequate skills and know-how in handling some of the commonest tasks in chemistry practical. This trend of events if not checked by the continual reappraisal of the utilization and functioning capacity of our laboratories will spell doom for collective dream of technological advancement.

Purpose of the Study

The aim of the study is to collect information on the availability and utilization of laboratory facilities in a selected few Colleges in North-Eastern Nigeria via structured questionnaires. This will provide valuable insight into the utilization of lab use in the classroom settings. The study also hopes to investigate the influence of lab use on academic achievements. This information will help policy makers understand the need to encourage its use teaching and learning chemistry.

Research Questions

The following questions guided the study:

1. What is the level of availability of lab facilities for teaching and learning?
2. To what extent is lab facilities utilized in teaching and learning?
3. What are the challenges hindering the utilization of lab in teaching/learning?

Methodology

The study adopted the survey research design to evaluate the availability and extent of utilization of laboratory facilities. The target population for this study consists of Chemistry Lecturers of five randomly selected Colleges of Education located in the North-Eastern Nigeria. The Colleges of Education are: Aminu Saleh College of Education, Azare, Bauchi, Bauchi State; Federal College of Education (Technical), Potiskum, Yobe State; Federal College of Education (Technical), Gombe, Gombe State; College of Education, Waka Biu, Borno State and Federal College of Education, Yola, Adamawa State.

The sample size for the study comprised of eight-nine (89) Chemistry Lecturers of the sampled Colleges of Education in North-Eastern Nigeria. Due to the small size of the study population that are also well dispersed, all the Chemistry Lecturers in each of the departments participated in the study.

This is in agreement with the assertion of Kalinga (2002) with a view that a larger sample size minimizes sampling error due to more representation yielding reliable and valid results.

A validated questionnaire tagged: Availability and Utilization of Chemistry Laboratory Facilities (AUCLF) was used for data collection. AUCFL comprised of three sections: Section A is on the level of availability and functionality of the laboratory. Section B elicit information on effective use of the laboratory and Section C dealt with challenges facing the effective use of the laboratory. AUCLF was constructed and scored based on 4-point Likert scale type using Strongly Agree (SA)-4, Agree (A)-3, Disagree (D)-2 and Strongly Disagree (SD)-1 and Highly Utilized-4, Utilized-3, Rarely Utilized-2 and Not Utilized-1 respectively as adopted by Akinwumi *et al*., (2021). A decision rule was set as follows: Accept all means ≥ 2.50 and reject means < 2.50. The reliability of the AUCLF was determined using the test-retest method for which a Cronbach Alpha of 0.80 was obtained. Hence AUCLF was deemed reliable line with Olayiwa (2010). Data collected was subjected to descriptive statistics of mean and standard deviation.

Results

The results are presented in tables followed immediately by report and discussion of findings.

Research Question One: What is the level of availability of lab facilities for teaching and learning?

Table 1: Descriptives on availability and functionality of the laboratory

	Items	Mean	Standard Deviation	Remark
1	There is laboratory (s) in the department	3.88	0.32	Agreed
2	There lab staff are qualified and up-dated	3.05	0.90	Agreed
3	Most of the lab equipment are functional	3.14	0.76	Agreed
4	The laboratory enjoys regular supply of basic facilities such as water, gas and power supply	3.17	0.67	Agreed
5	Basic apparatus, reagents and chemicals for effective teaching and learning are available	3.18	0.70	Agreed
6	There are basic safety equipment such as updated fire extinguishers, shower center, eye-wash units etc.	3.18	0.79	Agreed
7.	The lab has modern equipment such as AAS, GC-MS, UV-Visible spectrophotometer etc.	2.18	1.04	Disagreed
	Grand Mean	3.11	0.74	Agreed

Field Survey, 2022

The results in Table 1 is indicative of the presence of laboratories and its accessories for teaching and learning. The grand mean for the availability of lab/facilities is 3,11; revealing that laboratories are highly available (3.88) while qualified lab staff (3.05), functionality of equipment, basic lab requirements and basic safety equipment in the lab had means on the average of 3.18 suggesting that they are only moderately available. These findings are in contrast with those of Ibrahim *et al*. (2017) and Mojisola (2021) who decried lack of formidable, regular and stable laboratory facilities and accessories in teaching/learning chemistry; resulting in the use of alternative to chemistry practical syndrome in schools and colleges. However, the findings show that modern research equipment such as Atomic Absorption Spectrophotometer (AAS), Gas Chromatograph (GC) etc. are not available for use.

This portend danger for the future of our students as most researches in the areas of chemistry today largely rely on them.

Research Question Two: To what extent is lab facilities utilized in teaching and learning?

Table 2: Descriptives on the level of effective use of the laboratory

	Items	Mean	Standard Deviation	Remark
1	Equipment are available and adequately serve the purpose of teaching and learning	3.00	0.67	Agreed
2.	We conduct practical as stipulated by the curriculum and students submit reports of every experiment	2.99	0.70	Agreed
3	The teachers only guide students on the experiments during practical	2.95	0.67	Agreed
4	Students are engaged in hands-on practical activities in the lab	2.95	0.85	Agreed
5	Most of the students projects involve the use of the lab	2.48	0.83	Disagreed
6	Staff members do use the labs for personal or Institution Based Researches.	2.80	0.92	Agreed
	Grand Mean	2.86	0.77	Agreed

Field Survey, 2022

The grand mean for the utilization of the available (2.86) equipment is lower than the mean for its availability (3.11). This score line suggests that the laboratories are underutilized. This could be due to lack of incentives on the part of the government as only a paltry sum of three hundred a thirty-three naira thirty-three kobo (₦333.33) only is being paid as hazard allowance to lecturers and laboratory technologists in the colleges of education in Nigeria today.

The use of the laboratories for students' end of program projects ranked abysmally low with a mean value of 2.48 (disagreed). This lack of use could as well be traced to the two parties involved; trainers and trainees. Lack of interest or phobia for chemistry practical exercises or both. These findings are in agreement with Yusuf & Ali (2012) exhibit phobia and negative attitude towards chemistry practical. However, Uwague & Ojebah (2008) posited that most teachers and technologists are scared from conducting practical due to its associated hazards, obsolete materials and poor sanitary conditions of the laboratories.

Research Question Three: What are the challenges hindering the utilization of laboratories in teaching/learning?

Table 3: Descriptives on the challenges facing the effective use of the laboratory

	Items	Mean	Standard Deviation	Remark
1	Lack of motivation and interest in teaching practical by	2.65	1.15	Agreed
2	Feeling of lack of workplace safety	2.78	0.82	Agreed
3	Lack of basic amenities and facilities due to lack of funds to run the lab.	3.19	0.91	Agreed
4	Students do not show interest and enthusiasm	2.53	0.80	Agreed
5	Dearth of adequate qualified staff to conduct practical	2.29	0.77	Disagreed
6	Inexperience and incompetence in lab activities of laboratory staff	2.38	0.89	Disagreed
7	Lack of good maintenance of lab equipment	2.55	0.93	Agreed
	Grand Mean	**2.62**	**0.89**	**Agreed**

Field Survey, 2022

Table 3 sums up the analysis of the investigation into the likely impediments to effective use of the labs. While there was unanimous agreement to lack of motivation (2.65), lack of workplace safety (2.79), problem of logistics in running the lab (3.19), poor students` attitude (2.53) and poor maintenance culture (2.55). Most of the factors have been discussed under Table 2. However, adequacy of staff (2.29) and experience of the staff (2.38) not constitute challenges in the colleges sampled. It suffices it to mention therefore, that the challenges being encountered with the use of the laboratory those of poor funding, poor management of lab equipment, lack of adequate incentives and poor safety architecture. These are affirmed by Yusuf & Ali (2012), Ibrahim, *et al*. (2017), Olufunmilayo (2018) and Mojisola (2021) who reported that these factor militate against the effective teaching and learning of chemistry via laboratory practical.

Conclusion

The availability and utilization of laboratories across the sampled colleges of education is only at moderate level. More equipment as well as courage, enthusiasm and synergy is required for optimal result. It is pertinent at this juncture to state that the lecturers, teachers and technologists and other stakeholders should brace up to the prevailing challenges presented by the continually evolving technology. It is therefore, a must for the major key players to reskill and upskill in the use of laboratory for service delivery for global competitiveness.

Recommendations

On the basis of the challenges enumerated above, the study recommends as follows:

1. Staff emoluments and allowances, especially the hazard allowance should be subjected to periodic review with a view to encouraging them and boost their morale,
2. Adequate training and refresher courses in safety in the lab as well as providing safety facilities to raise their feeling of safety is advised,
3. Laboratory facilities and equipment should be provided. Other accessories include formidable internet facilities be made available in laboratories.

4. Lecturers and technologists should adequately enlighten students on the safe use of the lab to dispel any form of fear or anxiety.
5. Regular training and re-training of lab technologists by relevant bodies such as Nigerian Institute of Science Laboratory Technologists (NISLT) is recommended.

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