Puissant – A Multidisciplinary Journal (ISSN print: 2719-0153; ISSN online: 2719-0161)
Vol. 4, pp. 1005-1019
https://puissant.stepacademic.net

Short Paper

Knowledge and Implementation of Laboratory Safety Skills Possessed by Pre-Service Science Teachers in Anambra State, Nigeria: Implications for Practical Science Learning

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Date received: July 8, 2022
Date received in revised form: August 17, 2022; August 22, 2022
Date accepted: August 22, 2022

Recommended citation:

Nwune, E. C., Oguezue, N. K., Samuel, N. N. C., & Okwuduba, E. N. (2023). Knowledge and implementation of laboratory safety skills possessed by Pre-Service Science Teachers in Anambra State, Nigeria: Implications for practical science learning. *Puissant*, 4, 1005-1019.

Abstract

The study investigated the knowledge and implementation of laboratory safety skills possessed by pre-service science teachers in Anambra State, Nigeria: Implications for practical science learning. The study's main purpose was to determine the knowledge and implementation of laboratory safety skills possessed by pre-service science teachers in Anambra State, Nigeria. Six research questions guided the conduct of the study. The study adopted the descriptive survey research design. The population is comprised of 2722 pre-

service science teachers in Anambra State. A sample of 360 pre-service science teachers obtained using a multi-stage sampling procedure was used for the study. The instrument titled "Laboratory Safety Skills Questionnaire (LSSQ)", adapted from Muhammad (2017) was used to collect data for the study. The instrument was validated by relevant experts, and the reliability test conducted on the instrument using the Cronbach Alpha technique gave an index of 0.84. Data were collected using Google forms. Descriptive statistics (mean and standard deviation) were used to analyze the collected data. Based on the findings, the study revealed that pre-service science teachers possess a high level of knowledge of laboratory safety skills but implement the knowledge on a moderate level. The findings also showed a disparity in the NCE and Undergraduate degree pre-service science teachers' level of knowledge and implementation of laboratory safety skills. It was recommended amongst all those teachers and other relevant stakeholders should emphasize more on laboratory procedures, to give students more opportunities to implement the knowledge of the laboratory safety skills that they possess.

Keywords – laboratory safety skills, knowledge & implementation, pre-service science teachers, degree, NCE

INTRODUCTION

Science education involves the exposition of learners to science content and processes both in formal and informal educational settings. Science education, according to Aina (2013), concentrates on the teaching of science concepts, methods of teaching, and addressing misconceptions held by learners regarding science concepts. It is very crucial for the development of any nation in the world. Osuafor and Okonkwo (2013) described science education as occupying the central position for producing resources necessary for any nation's socio-economic, scientific, and technological development. Also, Badmus and Omosewo (2018) considered science education as a veritable tool needed for shaping and moulding the character of modern society. Science education can be considered the gateway to every nation's exit from mediocrity and under-development.

According to Aina (2013), science education in Nigeria comprises primarily of three subjects, namely Biology, Chemistry, and Physics, taught at the senior secondary school levels and higher institutions of learning. These three subjects form the basis of what is called science education in Nigeria and also require laboratory procedures as a veritable and indispensable means of teaching them (Akani, 2015). This is to say that the effective teaching of sciences depends largely on strict adherence to laboratory safety measures.

Kalkan and Deniz (2013) defined laboratory safety as observing specific laboratory rules and the appropriate utilization of laboratory facilities. Laboratory safety can be seen as taking adequate precautions against possible accidents during laboratory procedures. According to Caymaz (2021), these accidents are probable when safety measures are

ignored. Also, Osuafor and Ezeobi (2017) attributed laboratory accidents to teachers' poor laboratory management. This poor management can result from inadequate laboratory safety skills knowledge and implementation.

This present study is necessary because there was limited literature on laboratory safety skills and implementation in Anambra State. Also, the available literature focused mainly on secondary schools. The present study, however, focused on pre-service science teachers because they are trained to take up science teaching and laboratory assistantship positions in secondary schools. These pre-service science teachers are expected to be at the front burner when it comes to laboratory skills knowledge and implementation in secondary schools. The present study is an attempt to fill this gap.

Purpose of the Study

The main purpose of the study was to determine the knowledge and implementation of laboratory safety skills possessed by pre-service science teachers in Anambra State, Nigeria. Specifically, the study sought to determine the;

1. level of knowledge of laboratory safety skills possessed by pre-service science teachers in Anambra State, Nigeria
2. level of implementation of laboratory safety skills of pre-service science teachers in Anambra State, Nigeria
3. level of knowledge of laboratory safety skills possessed by pre-service science teachers in Anambra State, Nigeria, according to their academic programmes
4. level of implementation of laboratory safety skills of pre-service science teachers in Anambra State, Nigeria, according to their academic programs

Research Questions

The following research questions guided the conduct of the study:

1. What is the level of knowledge of laboratory safety skills possessed by pre-service science teachers in Anambra State, Nigeria?
2. What is the level of implementation of laboratory safety skills of pre-service science teachers in Anambra State, Nigeria?
3. What is the level of knowledge of laboratory safety skills possessed by NCE pre-service science teachers in Anambra State, Nigeria?
4. What is the level of implementation of laboratory safety skills of NCE pre-service science teachers in Anambra State, Nigeria?
5. What is the level of knowledge of laboratory safety skills possessed by undergraduate degree pre-service science teachers in Anambra State, Nigeria?
6. What is the level of implementation of laboratory safety skills for undergraduate degree pre-service science teachers in Anambra State, Nigeria?

LITERATURE REVIEW

Laboratory Procedures and the School Laboratory

Laboratory procedures refer to any type of science teaching and learning activities that involves students working together, either individually or in a small group, to manipulate processes and experience first-hand observation of real objects and materials (Famuwagun, 2019). These activities usually take place in the school laboratory and are geared toward helping students to develop science process skills, enhance the learning of scientific knowledge, give insight into the scientific method, stimulate students' interest, increase motivation to study science, and develop scientific attitude, such as open-mindedness, objectivity amongst others. More so, these activities in the school laboratories help students to understand complex and abstract ideas, allow students to actively participate in the teaching and learning process, and also express appreciation for the process and method of science.

The school laboratory, according to Fagihi (2018), is one of the most important fields of practice, where practical experiments are carried out to transfer knowledge from concepts, principles, and theories to tangible results that can be observed, measured, controlled and re-tested in different conditions according to new variables. Fagihi (2018) further posited that since the school laboratory is the most important learning environment and the most widely used in teaching science to achieve effectiveness in science teaching and learning, the knowledge and implementation of safety skills in the laboratory by laboratory users are very paramount. Some of these safety skills, according to Muhammad (2017), include but are not limited to safety consciousness skills, accident prevention skills, experimental procedure skills, and skills in the management and control of laboratory activities.

To effectively harness the prospects of laboratory procedures, there is a need for efficient knowledge and implementation of safety skills in the laboratory to guard against accidents that could impede the effective use of the laboratory and thus limit the full maximization of its potential in the development of science. The goal of emphasizing these laboratory safety skills knowledge and implementation is borne out of those accidents that have occurred globally in university laboratories, which includes, amongst others, the death of Sheri Sangji at the University of California Los Angeles in the United States (Allen, 2014), the chemical explosion at the Beijing Jiatong University laboratory in China (Lixin, 2018), the death of a professor after a severe lab explosion at the Technion-Israel Institute of Technology (Staff, 2019) and the serious injury sustained by a student in a chemical spill accident at the University of Kent (Chantler-Hicks, 2020) as well as the need to avert future occurrences.

In Nigeria, Igwe (2003) posited that several accidents occur during laboratory procedures in secondary school laboratories. Ibiam and Idoko (2008) identified the presence of chemicals and poor handling of equipment as some of the causes of laboratory accidents in secondary schools in Enugu State. Nwanuma (2005) and Nkwegu (2008)

reported fire outbreaks in some secondary school laboratories in Ebonyi State. The researchers attributed these accidents to the absence of functioning laboratory safety equipment. Also, in Anambra State, Emendu (2007) and Osuafor and Ezeobi (2017) identified several factors that cause accidents in secondary school laboratories. The researchers highlighted the factors to include the incorrect design of laboratories and poor management of laboratories, crowded classes, unwanted students behaviours, carelessness, the absence of laboratory safety skills knowledge, and its implementation in the laboratories, and the absence or inadequacy of laboratory safety equipment.

Pre-service Science Teachers

Pre-service science teachers are those undergoing training in any of the science fields to become professional instructors in the specific scientific field of their choice. They are also called student teachers. Pre-service science teachers are the undergraduate students of higher institutions such as colleges of education who obtains a National Certificate in Education (NCE) on completion of study and education faculties in universities who obtain a Bachelor of Science in Education (BSc. Ed) on completion of the study. These institutions prepare students to become professional teachers by helping them connect the gap between theory and practice. The pre-service science teachers' training programmes seek, amongst other things, to equip pre-service science teachers with relevant theoretical and practical knowledge and competence, equip them with relevant skills for optimum productivity as science teachers, as well as prepare them for the development of their students and the society at large.

Since these institutions seek to achieve the aforementioned objectives in pre-service in their different pre-service programmes, it is thus expedient to ascertain the level of knowledge and implementation of laboratory safety skills possessed by these pre-service science teachers. It is upon this that the present study is anchored.

METHODOLOGY

Research Design

The study adopted a descriptive survey research design. According to Nworgu (2015), this type of research design involves a well-detailed critical examination of a situation to find what it is and how it is. This makes the research design suitable for the study.

Population and Sample Size of the Study

The population of the study comprised 2722 pre-service science teachers in higher institutions in Anambra State. The sample of the study was determined using a multi-stage sampling procedure. The first stage involved placing the population into two strata of

public universities (Nnamdi Azikiwe University, Awka, and Chukwuemeka Odumegwu Ojukwu University, Uli) and colleges of education (Federal College of Education Technical (FCET) Umunze and Nwafor Orizu College of Education, Nsugbe) in Anambra State. The second stage involved a random selection of Nnamdi Azikiwe University, Awka and Federal College of Education (Technical), Umunze from the strata. The third stage involved using simple random sampling in selecting three hundred and twenty-two (322) regular program pre-service science teachers from Nnamdi Azikiwe University, Awka, and Thirty-eight (38) NCE students from Federal College of Education Technical (FCET), Umunze. The sample covers first-year to final-year students.

Instrument for Data Collection

The instrument titled "Laboratory Safety Skills Questionnaire (LSSQ)", adapted from Muhammad (2017) was used to collect data for the study. The LSSQ is made up of 20 items in two sections; section A was used to obtain bio-data of the respondents, while section B was used to obtain information on the level of laboratory safety skills knowledge possessed by the pre-service science teachers as well as their level of implementation of these safety skills in the laboratory. Section B was developed with a five-point Likert type rating scale of very high level (VHL), high level (HL), moderate level (ML), low level (LL), and very low level (VLL) with weights of 5, 4, 3, 2, 1 for positive statements and 1, 2, 3, 4, 5 for negative statements. Relevant experts validated the instrument, and a reliability index of 0.84 was obtained for the instrument using the Cronbach alpha technique. The value reveals the instrument is reliable.

Descriptive statistics (mean and standard deviation) were used to analyze the collected data and to make decisions regarding the items in the questionnaire. Decisions were taken as follows (Table 1)

Table 1. Decision Rule

1	1.00-1.49	Very Low Level
2	1.50-2.49	Low Level
3	2.50-3.49	Moderate Level
4	3.50-4.49	High Level
5	4.50-5.00	Very High Level

RESULTS

Research Question One: What is the level of laboratory safety skills knowledge possessed by pre-service science teachers in Anambra State, Nigeria?

The result in Table 2 below shows that the pre-service science teachers have a high level of knowledge of laboratory safety skills. This can be seen from the grand mean (3.58) of the students' mean responses with a standard deviation (0.79), as shown in the table, which is within the high-level boundary.

Table 2. Students' Mean Responses on their Knowledge of Laboratory Safety Skills

S/N	ITEM	N	$\bar{x}$	SD	REMARK
1	I am aware of safety equipment in the laboratory	360	4.07	0.79	High Level
2	I am ignorant of safety precautions/signs in the laboratory	360	3.97	1.12	High Level
3	I know possible preventive measures to be taken to avert laboratory accidents	360	3.95	0.91	High Level
4	I can organize the laboratory properly	360	3.66	0.87	High Level
5	I can properly ventilate and light up the laboratory	360	3.64	0.86	High Level
6	I am aware of corrosive and non-corrosive laboratory chemicals	360	3.37	0.96	Moderate Level
7	I know how to properly use laboratory equipment for any given laboratory	360	3.48	0.85	Moderate Level
8	I know the steps involved in any given laboratory procedure	360	3.21	0.85	Moderate Level
9	I am aware of laboratory personal protective equipment (PPE)	360	3.56	0.91	High Level
10	I can administer first aid treatment in cases of a laboratory accident	360	3.24	1.05	Moderate Level
11	I am aware of the laboratory emergency exit plan	360	3.33	0.98	Moderate Level
	GRAND MEAN	**360**	**3.58**	**0.79**	**High Level**

Research Question Two: What is the level of laboratory safety skills implementation by pre-service science teachers in Anambra State, Nigeria?

The grand mean responses of the students (3.25) with a standard deviation (1.00), as shown in table 3 below, shows that pre-service science teachers implement moderately the high level of knowledge of laboratory safety skills that they possess in carrying out experimental procedures.

Table 3. Students' Mean Responses on their Implementation of their Laboratory Safety Skills

S/N	ITEM	N	$\bar{x}$	SD	REMARK
1	I obey laboratory rules	360	4.20	0.86	High Level
2	I am usually carefree when carrying out laboratory procedures	360	3.12	1.44	Moderate Level
3	I am involved in the organization of the laboratory	360	3.20	0.99	Moderate Level
4	I ensure there is proper ventilation and lightning in the laboratory during each laboratory procedure	360	3.59	0.88	High Level
5	I apply the required steps involved in any given laboratory procedure	360	3.87	0.85	High Level
6	I am not efficient in operating laboratory equipment needed for laboratory procedure	360	3.41	0.96	Moderate Level
7	I have my laboratory personal protective equipment (PPE)	360	2.89	1.13	Moderate Level
8	I do not use my laboratory PPE while carrying out laboratory procedures	360	3.86	0.95	High Level
9	I use the emergency equipment in the laboratory when necessary	360	3.72	1.00	High Level
	GRAND MEAN	**360**	**3.25**	**1.00**	**Moderate Level**

Research Question Three: What is the level of laboratory safety skills knowledge possessed by NCE pre-service science teachers in Anambra State, Nigeria?

The result in table 4 below shows that pre-service teachers in the NCE programme have a moderate level of knowledge of laboratory safety skills. This is evident from their grand mean response (3.43) with a standard deviation (0.98).

Table 4. NCE Students' Mean Responses on their Knowledge of Laboratory Safety Skills

S/N	ITEM	N	$\bar{X}$	SD	REMARK
1	I am aware of safety equipment in the laboratory	360	4.05	0.91	High Level
2	I am ignorant of safety precautions/signs in the laboratory	360	3.26	1.28	Moderate Level
3	I know possible preventive measures to be taken to avert laboratory accidents	360	3.79	1.13	High Level
4	I can organize the laboratory properly	360	3.42	1.01	Moderate Level
5	I can properly ventilate and light up the laboratory	360	3.42	0.83	Moderate Level
6	I am aware of corrosive and non-corrosive laboratory chemicals	360	3.32	1.00	Moderate Level
7	I know how to properly use laboratory equipment for any given laboratory	360	3.21	0.85	Moderate Level
8	I know the steps involved in any given laboratory procedure	360	3.05	0.84	Moderate Level
9	I am aware of laboratory personal protective equipment (PPE)	360	3.26	0.80	Moderate Level
10	I can administer first aid treatment in cases of a laboratory accident	360	3.47	1.21	Moderate Level
11	I am aware of the laboratory emergency exit plan	360	3.53	1.02	High Level
	GRAND MEAN	**360**	**3.43**	**0.98**	**Moderate Level**

Research Question Four: What is the level of laboratory safety skills implementation of NCE pre-service science teachers in Anambra State, Nigeria?

The grand mean responses of the students (3.40) with a standard deviation (0.99), as shown in table 5 below, shows that NCE pre-service science teachers implement moderately the moderate level of knowledge of laboratory safety skills that they possess in carrying out experimental procedures.

Table 5. NCE Students' Mean Responses on the Implementation of their Laboratory Safety Skills

S/N	ITEM	N	$\bar{x}$	SD	REMARK
1	I obey laboratory rules	360	4.05	0.97	High Level
2	I am usually carefree when carrying out laboratory procedures	360	2.42	1.34	Low Level
3	I am involved in the organization of the laboratory	360	3.42	0.83	Moderate Level
4	I ensure there is proper ventilation and lightning in the laboratory during each laboratory procedure	360	3.53	0.84	High Level
5	I apply the required steps involved in any given laboratory procedure	360	3.79	0.71	High Level
6	I am not efficient in operating laboratory equipment needed for laboratory procedure	360	3.05	0.97	Moderate Level
7	I have my laboratory personal protective equipment (PPE)	360	3.16	1.16	Moderate Level
8	I do not use my laboratory PPE while carrying out laboratory procedures	360	3.68	0.88	High Level
9	I use the emergency equipment in the laboratory when necessary	360	3.58	1.21	High Level
	GRAND MEAN	**360**	**3.40**	**0.99**	**Moderate Level**

Research Question Five: What is the level of laboratory safety skills knowledge possessed by undergraduate degree pre-service science teachers in Anambra State, Nigeria?

The result in table 6 below shows that pre-service science teachers in the undergraduate degree programme possess a high level of knowledge of laboratory safety skills. This is evident from the grand mean of the students' responses (3.60) with a standard deviation (0.91).

Table 6. Undergraduate Degree Students' Mean Responses on their Knowledge of Laboratory Safety Skills

S/N	ITEM	N	$\bar{x}$	SD	REMARK
1	I am aware of safety equipment in the laboratory	360	4.07	0.78	High Level
2	I am ignorant of safety precautions/signs in the laboratory	360	4.05	1.08	High Level
3	I know possible preventive measures to be taken to avert laboratory accidents	360	3.97	0.88	High Level
4	I can organize the laboratory properly	360	3.68	0.86	High Level
5	I can properly ventilate and light up the laboratory	360	3.66	0.86	High Level
6	I am aware of corrosive and non-corrosive laboratory chemicals	360	3.37	0.96	Moderate Level
7	I know how to properly use laboratory equipment for any given laboratory	360	3.52	0.85	High Level
8	I know the steps involved in any given laboratory procedure	360	3.22	0.85	Moderate Level
9	I am aware of laboratory personal protective equipment (PPE)	360	3.59	0.92	High Level
10	I can administer first aid treatment in cases of a laboratory accident	360	3.22	1.03	Moderate Level
11	I am aware of the laboratory emergency exit plan	360	3.31	0.98	Moderate Level
	GRAND MEAN	**360**	**3.60**	**0.91**	**High Level**

Research Question Six: What is the level of laboratory safety skills implementation of undergraduate degree pre-service science teachers in Anambra State, Nigeria?

The result (3.55±1.00) from table 7 below shows that undergraduate degree pre-service science teachers implement a high level, high level of knowledge of laboratory safety skills which they possess in carrying out experimental procedures in the laboratory.

Table 7. Under Degree Students' Mean Responses on their Implementation of their Laboratory Safety Skills

S/N	ITEM	N	$\bar{x}$	SD	REMARK
1	I obey laboratory rules	360	4.22	0.87	High Level
2	I am usually carefree when carrying out laboratory procedures	360	3.20	1.44	Moderate Level
3	I am involved in the organization of the laboratory	360	3.17	1.01	Moderate Level
4	I ensure there is proper ventilation and lightning in the laboratory during each laboratory procedure	360	3.60	0.88	High Level
5	I apply the required steps involved in any given laboratory procedure	360	3.88	0.87	High Level
6	I am not efficient in operating laboratory equipment needed for laboratory procedure	360	3.45	0.95	Moderate Level
7	I have my laboratory personal protective equipment (PPE)	360	2.86	1.13	Moderate Level
8	I do not use my laboratory PPE while carrying out laboratory procedures	360	3.88	0.96	High Level
9	I use the emergency equipment in the laboratory when necessary	360	3.74	0.97	High Level
	GRAND MEAN	**360**	**3.55**	**1.00**	**High Level**

DISCUSSION

The summary of the results in tables 2 and 3 shows that pre-service science teachers in Anambra State, as covered within the scope of this study, possess a high level of knowledge of laboratory safety skills but implement the knowledge moderately in carrying out laboratory procedures. This finding implies that the pre-service science teachers are taught more science theories but are given lesser opportunities to experiment with these theories during laboratory procedures. This gap between theory and practical science learning accounts for the pre-service science teachers' moderate level of implementation of their knowledge of laboratory safety skills. While the findings in table 4 and 5 shows that the NCE pre-service science teachers possess a moderate level of knowledge of laboratory safety skills with the moderate implementation of the knowledge, the findings in table 6 and 7 shows that the undergraduate degree pre-service science teachers possess a high level of knowledge of laboratory safety skills with the high implementation of the knowledge. This finding shows that there is a gap between the level of knowledge and implementation of laboratory safety skills between undergraduate degree pre-service science teachers and their NCE counterparts. This gap could be because the undergraduate degree pre-service science teachers are taught more science theories and given more opportunities to practice, unlike the pre-service science teachers in the NCE programme.

The findings of this study are contrary to one of the findings of Emendu (2007) and Osuafor and Ezeobi (2017). These researchers posited that the absence of laboratory safety skills knowledge and its implementation in the laboratory during laboratory procedures is one of the many factors that cause hazards and accidents in school laboratories in Anambra State. The findings from this study observed, however, that the pre-service science teachers as captured in this study possess a high level of knowledge of laboratory safety skills and implemented the knowledge during laboratory procedures; therefore, laboratory accidents cannot be attributed to the absence of laboratory safety skills knowledge and its implementation by students. Based on the findings of this study, the researchers posit that accidents in school laboratories cannot be attributed to students' ignorance or implementation of laboratory safety skills but rather to other factors such as the lack or insufficiency of laboratory safety equipment, teacher-related experimental procedures errors, poor design and management of the laboratory, and unforeseen environmental conditions such as fire outbreaks, gas leakages, etc.

CONCLUSIONS AND RECOMMENDATIONS

From the findings of the study, it was discovered that pre-service science teachers, as captured within the scope of this study, possess the knowledge of laboratory safety skills at a high level but implement the knowledge moderately in carrying out experimental procedures.

Secondly, the knowledge and implementation levels of laboratory safety skills for NCE pre-service science teachers were at a moderate level, while those of undergraduate degree pre-service science teachers were at a high level.

From the findings of the study, it was recommended that teachers and other relevant stakeholders should lay more emphasis on the use of laboratory procedures to boost students' implementation of the knowledge of laboratory safety skills that they possess, from a moderate level to a higher level. Also, it was recommended that Curriculum planners emphasize more the knowledge and implementation of laboratory safety skills in preparing practical manuals for experimental procedures. Again, routine checks of laboratory facilities should be observed to avert possible accidents in the laboratory. Similarly, adequate laboratory safety equipment should be provided for school laboratories. Finally, qualified and experienced teachers should be recruited to teach sciences in secondary schools.

IMPLICATIONS

Science is a learning field requiring laboratory or experimental procedures for effective content delivery. The subject matter of the sciences at all levels of our educational system requires some form of experiments and laboratory sessions from teachers and students for meaningful teaching and learning to occur. In ensuring the actualization of

meaningful teaching and learning of science subject matter using laboratory procedures, the place of the knowledge and implementation of laboratory safety skills in carrying out these procedures cannot be overemphasized. Science as a practical field of learning requires deliberate laboratory procedures for its advancement. The laboratory procedures cannot be successfully and effectively carried out without sufficient knowledge and implementation of safety skills to ensure the safety of teachers and students.

The findings of this study show that pre-service science teachers possess and implement the knowledge of laboratory safety skills. The finding indicates that pre-service science teachers covered in this study are exposed to laboratory procedures. Since the knowledge and implementation of laboratory safety skills are needed for the successful conduct of laboratory procedures, which in turn is essential for meaningful science teaching and learning, the pre-service science teachers in this study can be said to be involved in the sciences.

Similarly, the knowledge of laboratory safety skills possessed and implemented by pre-service science teachers can be transferred eventually into secondary school laboratories and other laboratory centres during their active teaching service. This, in essence, will promote practical science learning through these pre-service science teachers. The promotion of practical science learning by these pre-service science teachers will give room for national advancement of science and technology. Also, as the pre-service science teachers implement the knowledge of laboratory safety skills that they possess during active service, they tend to inspire and encourage their students to love and appreciate science and inculcate in them science process skills and ethics.

REFERENCES

Aina, J. K. (2013). Effective teaching and learning in science education through Information and communication technology [ICT]. *IOSR Journal of Research and Method in Education*, 2(5), 43-47.

Akani, O. (2015). Laboratory Teaching: Implication of Students' Achievement in Chemistry in Secondary Schools in Ebonyi State of Nigeria. *Journal of Education and Practice*, 6(30), 206-213.

Allen, K. (2014, March 30). A young lab worker, a professor and a deadly accident. The Star. https://www.thestar.com/news/world/2014/03/30/a_young_lab_worker_a_professor_ana_a_deadly_accident.html

Badmus, O. T. & Omosewo, E. O. (2018). Improving science education in Nigeria: The role of key stakeholders. *European Journal of Health and Biology Education*, 7(1), 11-15.

Caymaz, B. (2021). Secondary School Students' Knowledge and Views on Laboratory Safety. *Journal of Science Learning*, 4(3), 220-229.

Chantler-Hicks, L. (2020, February 25). Canterbury student taken to hospital after chemical spill at University of Kent campus. Kent Online. https://www.kentonline.co.uk/

Fagihi, Y. A. (2018). The Level of Awareness of Safety Measures Practiced in School Laboratories among Pre-Service Science Teachers at Najran University. *Journal of Educational Issues*, 4(1), 107-121.

Famuwagun S. T. (2019). *Effect of Virtual Laboratory Instructional Package on Student's Learning outcomes in Chemistry Ondo State, Nigeria*. Unpublished PhD. Thesis of the Department of Science Education, Ekiti State University, Nigeria.

Ibiam J. M., & Idoko, E. A., (2008). A survey of laboratory safety in secondary school in Nsukka Local Government Area. An unpublished B.Sc (Ed) project of the Department of Science Education, UNN.

Igwe, I. O. (2003). Principles of science and science teaching in Nigeria (An introduction). *Enugu: Jones Communications Publishers*.

Kalkan, M. E., & Deniz, V. (2013). On the concept of risk. *TTB Journal of Occupational Health and Safety*, *13* (48), 43-48.

Lixin, Z. (2018, December 26). Lab blast kills three students in Beijing University. Chinadaily.http://www.chinadaily.com.cn/a/201812/26/WS5c233187a310d91214051076.html

Muhammad, R. (2016). Assessing the laboratory safety and security skills among science, technology and mathematics (STM) teachers in Sokoto State, Nigeria. *American Journal of Education and Learning*, *1*(2), 62-68.

Nkwegu, V. N. (2008). *Adequacy of safety measures in chemistry laboratories in secondary schools in Ikwo L.G.A of Ebonyi State*: An unpublished NCE project of the department of chemistry Ebonyi State College Education, Ikwo.

Nwanuma T.N., (2008), Laboratory safety awareness of secondary school students in Ikwo L.G.A. Ebonyi State. An unpublished NCE project of the Department of chemistry Ebonyi State College of Education Ikwo.

Nworgu, B. G. (2015). Research Method and Statistics. *Enugu: African First Publishers, Enugu, Nigeria*.

Osuafor, A. M. & Ezeobi, G. O. (2017). Extent of organization and management of biology laboratory in senior secondary schools in Awka South Local Government Area. *UNIZIK Jornal of STM Education*, 2(1), 100-111.

Osuafor, A. & Okonkwo, I. (2013). Influence of family background on academic achievement of secondary school biology students in Anambra State. *African Research Review*, *7*(3), 156-167.

Staff, T. (2019, October 26). Technion professor dies after suffering serious injury in lab explosion. Retrieved from The Times of Israel, https://www.timesofisrael.com/technion-professor-dies-after-suffering-serious-injury-in-lab-explosion/