

Knowledge Level of Laboratory Safety Skills Possessed by Primary Education Pre-Service Teachers in Colleges of Education in South-East Nigeria: Implications for Practical Mathematics Learning

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ABSTRACT

The study examines the knowledge level of laboratory safety skills possessed by primary education pre-service teachers in Imo State: Implications for practical mathematics learning. This study was carried out in tertiary institutions in Imo State. Based on the purpose of the study, three research questions and two hypotheses guided the study at a 0.05 level of significance. The study adopted a descriptive research design. The population of the study comprised 105 Pre-service teachers in the School of Early Childhood Care and Primary Education. A sample size of 95 Pre-service teachers was used for the study, involving 40 males and 55 females. The instrument used for data collection was a structured Questionnaire titled Knowledge Level of Laboratory Safety Skills Questionnaire (KLLSSSPT). The reliability coefficient (r) of 0.82 was obtained using the Cronbach alpha method. Data collected were analysed using mean, standard deviation for the research questions, while t-test and ANOVA were used to test the hypotheses at 0.05 level of significance. The results showed that Pre-service teachers possess a high level of knowledge of laboratory safety skills and showed no disparity in gender and NCE Programme (Regular, Evening and Sandwich) pre-service teachers' level of knowledge of laboratory safety skills. It was recommended that all those teachers and other relevant stakeholders should emphasise laboratory procedures more, to give students more opportunities to implement the knowledge of laboratory safety skills that they possess.

Keywords: *Laboratory Safety Skills, knowledge, Pre-service Teachers and Practical Mathematics Learning*

INTRODUCTION

Mathematics, according to the National Policy on Education, is a core subject, up to secondary school levels of Education in Nigeria (FGN, 2014). It serves as a foundation for pupils' level of thinking, skill development and problem-solving. Any nation that must develop its manpower scientifically and technologically must have a strong mathematical foundation at the basic school level (Malik & Salman, 2018). That is to say that any nation that relegates Mathematics to the background does so at the risk of remaining a technologically backward nation in a jet-moving world ruled by science and technology. In line with this point of view, Malik (2020) opined that Mathematics is a unifying subject that prepares pupils for a useful and meaningful living, and that Mathematics is the language and key to everyday activities of mankind in science and technology.

Furthermore, Davies and Hersh (2012) see Mathematics as an important subject not only from the point of view of getting an academic qualification at school or college, but also as a subject that prepares the students for the future as well, irrespective of which work of life they choose to be a part of. Mefor (2014) summarised it all by saying that Mathematics relates to everything in the universe, from the smallest to the largest. Anaduaka and Okafor (2013) consider Mathematics as one subject that is an integral part of everyone's life and affects virtually every field of human endeavour. For instance, a housewife requires a good sense or knowledge of ratios, estimation and calculation to enable her to prepare a pot of soup that has all the necessary ingredients in appropriate proportions (Anaeche, 2015). On a serious note, a student requires a good pass in Mathematics in the Senior School Certificate Examination or its equivalent if he/she is to gain admission to study any of the science courses like medicine, pharmacy, Physics, Chemistry, Computer Science, etc., in Universities or Colleges of Education.

From the above expressed points of view of the importance of Mathematics, it is necessary, just like in every profession, to assess the extent of the competencies possessed by the teachers who teach this subject, especially as it concerns the competencies required for handling Mathematics laboratories. This helps to improve the quality of services rendered by the teachers. In our schools, we lack good results in some of the subjects after every school certificate examination. Such a subject as Mathematics tends to have the poorest results. The scenario is worrisome and poses a threat to the advancement of the nation in general and Imo state in particular.

Commenting on the poor results of students in Mathematics examinations, Anaduaka & Okafor (2013) and Kurumeh & Uhon (2012) opine that Mathematics education in Nigeria is still in a deplorable state. The students' poor achievement in Mathematics has triggered a lot of reactions from Mathematics educators in the country. Therefore, to address this issue, Mathematics educators such as Harbor-Peters (2001), Obodo (2007), Iji (2012) and Anaeche (2020) explored different strategies to ensure that Mathematics is properly

taught and learnt in schools. Various attempts have been made to improve students' poor achievement in Mathematics in secondary school education, without any remarkable success. This could be due to a lack of appropriate competencies by Mathematics teachers in handling laboratory sessions during instruction. Mathematics teaching, just like any other science subject, should be activity oriented. It explains the need for a standard and well-equipped Mathematics laboratory in all secondary schools and even tertiary institutions, where Mathematics teaching and learning processes take place. Based on this, there is a need to explore the competencies possessed by Mathematics teachers handling Mathematics laboratories so as to enhance students' performance in the subject.

The mathematics laboratory is where laboratory techniques take place under the leadership of an experienced mathematics teacher who can handle the laboratory equipment very well. According to Ezike and Obodo in Obodo (2004), the mathematics laboratory is a room where things can be counted, ordered, recorded, packed, grouped, arranged, rearranged, measured, partitioned, constructed, experimented, among many other activities. From the foregoing, the Mathematics laboratory is built on the principles of learning by doing, students' centeredness, and from known to unknown. It accommodates both the fast and slow learners of Mathematics. This is why Obodo (2018) refers to it as a remedial environment where the advantaged or disadvantaged, the poorest or the best-gifted students may have active sensory experiences from which concepts emerged.

In the words of Ali (2024), the laboratory is central to effective science teaching and learning. A mathematics laboratory is a space or room set aside for mathematical experiments and practical activities. It is an organised setting where learners work in an informal manner, move around, discuss, choose their materials and method, and generally make and discover mathematical facts for themselves. Uwaezuoke and Charles-Ogan (2016) defined a mathematics laboratory as a place where students can learn and explore mathematical concepts and verify mathematical facts and theorems through a variety of activities using different materials. According to Adenegan (2014), a mathematics laboratory is a unique room or place, with relevant and up-to-date equipment known as instructional materials, designated for the teaching and learning of mathematics and other scientific or research work, whereby a trained and professionally qualified person (mathematics teacher) readily interacts with learners (students) on a specified set of instructions. The mathematics laboratory is a practical-oriented classroom or place where materials useful for the effective teaching and learning of mathematics are kept.

According to John (2017), the following are some of the numerous objectives of the mathematics laboratory, as it is meant to be:

- i. To inculcate permanent numeracy in the students. To make mathematics learning very meaningful to the students.
- ii. To lay a sound basis for scientific and reflective thinking among the students. To make mathematics learning exciting and enjoyable for the students.
- iii. To enable students to comprehend and internalise mathematical knowledge.

- iv. To generate interest in mathematics and provide a solid foundation or background in mathematics learning.
- v. To stimulate and encourage creativity among the students.
- vi. To equip the students to live effectively in our modern age of science and technology.
- vii. To bridge the long gap between mathematical abstracts/theory and concrete/practical.
- viii. To provide
- ix. To develop an attitude of enquiry. To remove the weakness of present-day mathematics education.
- x. To generate interest readily accessible, rich, manipulative materials to emphasise learning by doing in the subject.
- xi. To make the students divergent thinkers. It provides a means of practising cognitive and psychomotor skills.
- xii. It is a means of experimenting and verifying of mathematical theorems, principles, and axioms, which are already known by the students.

Generally, the following skills are expected to be developed in the students in their mathematics laboratory exposure: The ability to plan an experiment and analyze a mathematical problem into its component's parts, the ability to carry out an experiment/improvisation or demonstration and the ability to interpret the result of experiment/improvisation and draw a possible conclusion. Others skills inculcated in the students during mathematics laboratory practice are observation, formulating hypothesis, measuring, making operational definition, counting, communicating, Experimenting, Questioning. Mathematics Laboratory Equipment, classification, manipulating instruments, formulating mathematical models, manipulating variables, Predicting and drawing conclusion.

Furthermore, Eze and Ugwuoke (2020) view laboratory work as students' opportunity to participate in and appreciate the methods and processes of science. This implies that when students become actively involved in laboratory activities, their participation tends to motivate them and foster their interest in science, especially Mathematics. Stressing on the importance of laboratory activities, Aniodo (2008) listed the following importance of laboratory activities:

1. Laboratory work gives students an opportunity to participate and have an appreciation for the methods and spirit of science.
2. Practical experience promotes the development of skills with a wide range of generalizable effects.
3. Students enjoy activities and practical work and consequently become motivated and interested in science.

Safety is part of doing any job right. Learning how to be safe is an integral part of education. Thus, the teacher needs to acquire knowledge and skills in the proper location

and operation of laboratory equipment, knowledge of how hazardous materials are handled, knowledge of unsafe practices and skills in prudent practices. It is the responsibility of the mathematics teacher to prevent accidents by designing the teaching learning situation in such a way as to safeguard the lives of laboratory users and laboratory facilities. He must be able to provide instruction on prudent practices, appropriate precautions, potential hazards, emergency procedures and appropriate emergency responses..

Kalkan and Deniz (2013) defined laboratory safety as observing specific laboratory rules and the appropriate utilisation of laboratory facilities. Laboratory safety can be seen as taking adequate precautions against possible accidents. According to Caymaz (2021), accidents occur when safety measures are ignored. To effectively harness the prospects of laboratory safety, there is a need for efficient knowledge of laboratory safety skills.

Laboratory safety skills are essential for students to protect themselves and others from harm, injury or danger. Laboratory safety skills include awareness of safety equipment, safety precautions/signs, preventive measures, organisation of laboratory facilities, ventilation and light, steps involved in any given laboratory, awareness of laboratory personal protective equipment (PPE), use of first aid treatment and laboratory emergency exit plan. Rabi (2017) mentioned the following as laboratory safety skills: skills in good planning of laboratory activities, skills in proper organisation of laboratory work space, skills in proper arrangements of laboratory equipment and tools, skills in regular checking and servicing of laboratory equipment and skills in proper ventilation of laboratories to prevent suffocation and enhance visibility in laboratory work spaces. Allison (1982), Ezeh (2010) and Achimugu (2012) opine that some science teachers are sufficiently exposed to proper managerial skills to use, maintain and repair laboratory facilities. This study examines the knowledge level of laboratory safety skills possessed by primary education pre-service teachers in Colleges of Education in the South–East Zone.

The success of any student, among other factors, lies on his/her safety skills in managing and controlling their learning environment. The learning environment must be devoid of chaos and anarchy. It must be safe for the students. However, most graduates of the Nigerian education system are not sufficiently exposed to proper laboratory safety skills. According to Allison (2024), they lack the safety skills required for modern learning of mathematics. Achimugu (2012) also reported that mathematics students cannot display a correct understanding of the science process as they cannot organise and conduct practical classes safely. It is against this background that this study is set out to find out the laboratory safety skills among primary education pre-service teachers.

Purpose of the study

The purpose of this study was to determine the knowledge level of laboratory safety skills possessed by primary education pre-service teachers in tertiary institutions in Imo State, Nigeria. Specifically, the study sought to determine:

- i. The level of laboratory safety skills knowledge possessed by primary Education pre-service teachers in tertiary institutions in Imo State, Nigeria.
- ii. Whether there is a difference between male and female pre-service Primary education teachers in the level of laboratory safety skills knowledge possessed.
- iii. Whether there is a significant difference in the mean scores of regular, evening and sandwich pre-service teachers on the level of knowledge of laboratory safety skills they possess.

Research Hypotheses

H₀₁: There is no significant difference in the level of laboratory safety skills knowledge possessed by primary education pre-service teachers based on gender.

H₀₂: There is no significant difference in the level of laboratory safety skills knowledge possessed by primary education pre-service teachers based on programme.

METHOD

The study adopted a descriptive survey research design. The population comprised all Primary Education pre-service teachers in Colleges of Education in South-Eastern Nigeria. A sample of ninety-five (95) pre-service teachers was determined using a multi-stage sampling procedure. The first stage involved placing the population into two strata of States Colleges of Education, (Ihitte Uboma College, Owerri, Ohafia College of Education, Abia State) and Federal Colleges of Education (Federal College of Education (Technical) (FCET), Umunze, Nwafor Orizu College of Education, Nsugbe, Federal College of Education, Ehamfue, Enugu State). The second stage involved using a simple random sampling technique to select Ihitte Uboma College of Education, Owerri and Federal College of Education (Technical), Umunze. The instrument entitled: Laboratory Safety Skills Questionnaire (LSSQ) was used to collect data for the study. The LSSQ has two sections; Section A was used for the bio-data of the respondents, while Section B was for information on the level of laboratory safety skills knowledge possessed by the pre-service teachers. 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. The face and content validity were assessed by two experts in measurement and evaluation and one expert from the Mathematics teacher educators in the Primary Education Studies Department. 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 analyse the research question, while the hypotheses were tested at a 0.05 level of significance.

RESULTS AND DISCUSSION

Table 1: Students' Mean Responses on their Knowledge of Laboratory Safety Skills

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

Table 1 shows that 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 pre-service teachers' mean responses with a standard deviation (0.79), as shown in the table, which is within the high-level boundary.

Table 2: Mean and Standard deviation on Difference in the Level of Laboratory Safety Skills Knowledge Possessed by male and female Primary Education Pre-Service Teachers.

Gender	Mean score	SD
Male	3.32	1.05
Female	3.33	1.08

Table 2 indicates that male pre-service teachers have a mean score of 3.32 while the female pre-service teachers mean score of 3.33.

Table 2: Mean and Standard deviation on Level of Laboratory Safety Skills Knowledge Possessed by regularly, evening and sandwich primary Education pre-service teachers.

Program	Mean score	SD
Regular	3.37	1.05
Evening	3.36	1.03
Sandwich	3.36	1.03

Table 3 shows that the mean score of Laboratory Safety Skills Knowledge possessed by regularly (3.37), evening (3.36) and sandwich (3.36) Primary Education pre-service teachers.

Tale 4: T-test analysis on Gender

GENDER	N	MEAN	SD	df	t-Cal	t-tab	Decision
Male	40	3.32	0.86	93	29.05	1.96	Accept
Female	55	3.33	0.85				HO

Table 4 shows the calculated t-value of 29.05 is significant at 1.96 ($P < 0.05$) the null hypothesis that there is no significant difference in the level of laboratory safety skills knowledge possessed by male and female primary Education pre-service teachers is accepted and the researchers concludes that there is no significant difference in the level of laboratory safety skills knowledge possessed by male and female primary education pre-service teachers.

Table 5: Analysis of variance on the mean scores of regular, evening and sandwich primary education pre-service teachers on the level of laboratory safety skills knowledge possessed by primary education pre-service teachers based on programme

Source of Variation	Sum of Squares	of DF	Mean Square	F	Sign Level	Decision
Between Groups	219.007	2	109.503	2.754	0.065	
Within Groups	11807.940	92	39.757			Accepted HO
Total	2026.947	94				

The result of the test of the hypothesis reveals that the F-value is less than the table value at a 0.05 level of confidence (Table 5). The null hypothesis that there is no significant difference in the level of laboratory safety skills knowledge possessed by primary education pre-service teachers based on the programme is, therefore, accepted. This implies that there is no significant difference in the ratings of regular, evening and sandwich primary

education pre-service teachers on the level of laboratory safety skills knowledge possessed by primary education pre-service teachers based on programme.

The study shows that primary education pre-service teachers possess a high level of knowledge of laboratory safety skills in carrying out laboratory procedures in learning mathematics. This finding implies that the pre-service teachers are taught more practically and experimentally during laboratory procedures. The result is in accordance with the findings of Allison (1982), Ezeh (2010) and Achimugu (2012), who opined that most science teachers are exposed to proper managerial skills in the area of use, maintenance and repairs to laboratory facilities. Also, the study indicates that there is no significant difference in the level of laboratory safety skills knowledge possessed by primary education pre-service teachers based on gender. Finally, there is no significant difference in the ratings of regular, evening and sandwich primary education pre-service teachers on the level of laboratory safety skills knowledge possessed by primary education pre-service teachers based on programme.

CONCLUSION

It was discovered that primary Education pre-service teachers possess the knowledge of laboratory safety skills at a high level in carrying out experimental procedures irrespective of gender and programmes.

Implications for Practical Mathematics Learning

Mathematics is a learning field requiring laboratory or experimental procedures for effective content delivery. The subject matter 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 actualisation of meaningful teaching and learning of mathematics subject matter using laboratory procedures, the place of the knowledge and implementation of laboratory safety skills in carrying out these procedures cannot be overemphasised. Mathematics, 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 primary education pre-service teachers possess knowledge of laboratory safety skills. The findings indicate that primary education pre-service teachers covered in this study are exposed to laboratory procedures. Since knowledge of laboratory safety skills is needed for the successful conduct of laboratory procedures, which in turn is essential for meaningful mathematics teaching and learning, the pre-service science teachers in this study can be said to be involved in mathematics learning.

Similarly, the knowledge of laboratory safety skills possessed by primary Education pre-service teachers can be transferred eventually into secondary school laboratories and other laboratory centres during their active teaching service. This, in essence, will promote practical learning through these pre-service teachers. The promotion of practical mathematics learning by these pre-service teachers will give room for the national advancement of mathematics and technology. As the pre-service 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 mathematics and inculcate in them science process skills, critical thinking, problem-solving skills and ethics.

Recommendations

From the findings of the study, it was recommended that

1. Teachers and other relevant stakeholders should underscore the laboratory procedures to boost students' implementation of the knowledge of laboratory safety skills that they possess.
2. Curriculum planners emphasise more the knowledge and implementation of laboratory safety skills in preparing practical manuals for experimental procedures.
3. Routine checks of laboratory facilities should be observed to avert possible accidents in the laboratory.
4. Adequate laboratory safety equipment should be provided for school laboratories. Finally, qualified and experienced teachers should be recruited to teach the sciences in secondary schools.

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