

Assessment of Laboratory Practices using Laboratory Practice Management Template as a Tool in Colleges of Education in North West Nigeria

Joseph Abiodun AYO; Hamisu Abubakar MAHARAZ & Aminu Isma'il YOLA

Department of Biology Education

Yusuf Maitama Sule Federal University of Education, Kano

Correspondence:

E-mail Address: joeayo64@gmail.com; Phone: 08034515315



Abstract

This study assessed Laboratory Practices using Laboratory Practice Management Template (LPMT) that would ensure high standards in laboratory practices for quality pre-service teacher production in Colleges of Education in North West Nigeria. The population for this study comprised all the lecturers and laboratory technicians in the science departments (Biology, Chemistry, Physics and Integrated Science) in seven states of North west Nigeria (N=385). Using the Research Advisers' technique, a sample of four (4) states (61%; n=235) was selected after applying the stratified random sampling technique to determine preconceived parameters (availability of key science courses and years of existence). Using the survey research design, five (5) objectives, corresponding research questions and hypotheses formed the basis upon which a researcher-designed Science Laboratory Practice Management Template Questionnaire (SLPMTQ) was developed, vetted and administered. Responses generated from the SLPMT questionnaire were collated and analysed using the Cronbach Alpha statistics that yielded an index of 0.78. The study employed the descriptive statistics of mean and standard deviation for observed responses, and inferential statistics of One-way ANOVA to test the formulated hypotheses, which were deemed significant at 0.05 alpha level. Results obtained revealed significant responses on safety protocols, equipment management practices, standard operating procedures, personnel management procedure and quality assurance technique. It was concluded that science laboratories should be operated in line with global best practices, and recommended that standard operating procedures and quality assurance techniques should be held sacrosanct for effective laboratory practices.

Keywords: Equipment, Laboratory, Management, Safety protocols, Quality assurance

Introduction

The continuous struggle for an educational system, which properly reflects Nigeria's quest for scientific and technological development, can no longer be waived aside because it is the basis for socioeconomic and political advancement of nations in the 21st century. This is why science education remains strong priority among other professional courses offered in our institutions of higher learning. The philosophy of teaching the course is principally that of instilling into the individual varied special science skills and attitude which the nation considers essential for her security, progress and modernization in this world of scientific enterprises (NCCE, 2003).

According to Gwamanja (1990), science education is the study of the interrelationship of science as a discipline and the application of education principles and theories that will foster the teaching and learning of sciences. The teaching and learning of science also require an enabling environment such as laboratory among other facilities. Thus, Tobin (2010) asserts that laboratory teaching is one of the hallmarks viewed from the angle of education research in the sciences, Eniayeju (2009) sees laboratory as a place equipped with scientific apparatus where scientists perform experiments and test hypotheses. Qualitative science education in Nigerian Colleges of Education will remain an illusion to be pursued and unattained if the teaching and learning of sciences is by mere lecture method without the provision of laboratories with adequate facilities. It is against this backdrop that National Commission for Colleges of Education (NCCE) (2012) recommends that:

- a) There should be at least three general laboratories one at each level of about 7.5m²
- b) There should be the provision for a technologist, technician, laboratory assistant and laboratory attendant for effective and efficient laboratory management.
- c) The students should be taught laboratory management.

To manage the laboratory and its facilities efficiently the following should be encouraged;

- i. Ensure safety protocols are maintained in the laboratory
- ii. Ensure laboratory equipment are well-maintained and managed
- iii. Institute standard operation procedures that should guide all activities in the laboratory
- iv. Laboratory personnel should be well-managed and
- iv. Maintenance of high-quality assurance in the procurement of apparatus or equipment

It is evident, therefore, that every accredited science laboratory in Colleges of Education must have at least four-support staff (paraprofessionals) who will join effort together with academic staff towards the realization of the science education aims and objectives in Colleges of Education. Furthermore, if the science education paraprofessionals combine efforts with academic staff in seeing to the smooth management of laboratory equipment and activities, it is assumed that science education laboratories in the Colleges of Education are well managed and put to maximum use. Nwachukwu (2002) maintained that despite the poor management our economic sectors, a re-orientation in management of educational facilities and equipment will yield positive results in the educational sectors.

Similarly, Ajewole, Oginni, and Okedeyi (2013) posited that facilities that are constructed; and equipment and apparatus that are purchased or that are in stock soon give way due to lack of maintenance, leading to malfunction of its various components. In

support of this, Ivowi (2004) emphasized on the dire need to employ maintenance culture so as to guard equipment, working tools, from becoming obsolete. If all these assertions are to be reckoned with, then Walberg's (2011) comment which questioned whether the great expense of maintaining and staffing laboratories are really justified cannot be overlooked.

It is worthy to note that the mandate of Colleges of Education is to produce middle level manpower for the basic education system as outlined in the NCCE minimum standards (NCCE, 2012). Therefore, these teachers-in-training, who are hitherto referred to as Pre-service teacher are involved in a school-based field experience. Pre-service teacher education is the education and training provided to student-teachers before they undertake any teaching experiences (Onwuegbuze, *et al.*, 2018). It is in this regard that this research work was carried out to assess laboratory practices while using the LPMT as a tool for ensuring standard laboratory practices for quality pre-service teacher production in Colleges of Education in North West Nigeria

Statement of the Problem

Laboratory management techniques/practices have been identified as the act of planning, organizing controlling, coordinating the laboratory and its equipment and its users so as to ensure their safety and longevity (Balogun, 2006; Mani, 2003). This is to ensure that instructional activity through which science processes such as the development of observatory skills, manipulative skills, experimenting skills and formulation of theoretical concept can best be achieved with adequately equipped and well-managed laboratory. The National Commission for Colleges of Education NCCE (2012) identified that science teacher training should place priority on laboratory management practices with a view to training the pre-service student teachers on how to manage laboratory and its facilities in their respective teaching stations at the basic school level. This assertion is supported by Oladimeji (2013) that a good laboratory management practice at this level will help to lay a solid foundation for the sciences at early life.

Another crucial aspect of science laboratories in tertiary institution in Nigeria and is that of mismanagement. The dissatisfaction has probably arisen from inability of teachers and paraprofessionals in Colleges of Education to employ good laboratory management practices in managing the laboratories effectively or because teachers and laboratory paraprofessionals are not adequately prepared for these tasks in Colleges of Education. A study of this nature will provide an impetus that will challenge stakeholders in ensuring due process that will have concomitant effect on the pre-service teachers (Jegede, 2000; Oladimeji, 2013).

Furthermore, the purpose of disseminating science knowledge and practice to teachers-in-training (pre-service teachers) is to ensure the training the acquire it practiced when they eventually practice at the basic school level. This study is premised upon that assertion and it is believed that a solid foundation will go a long way to entrenching the

values attached to sound laboratory management practices for the development of basic science practice in future. In the light of the above discussion, this study was carried out to develop laboratory practice management template (LPMT) to be employed by teachers, paraprofessionals etc. that will yield positive dividends for quality pre-service teacher production in selected Colleges of Education in North West Nigeria

Objectives of the Study

Specifically, the objectives of the study are to: -

1. assess the responses on safety protocols of Laboratory Practice Management Template (LPMT) for teachers and paraprofessionals in Colleges of Education in North west Nigeria.
2. examine the procedures of laboratory management equipment practices used by teachers and paraprofessionals in Colleges of Education in North west Nigeria
3. ascertain if there are standard operating procedures that are recommended in the LPMT for laboratories teacher production in North West Nigeria.
4. ascertain if the personnel management procedure meets the standard recommended in the LPMT for laboratories teacher production in North West Nigeria.
5. determine the quality assurance technique instituted in laboratories of Colleges of Education in North west Nigeria.

Research Questions: The following research questions were raised for the study:

1. What are the safety protocols of Laboratory Management Practice Template (LPMT) for teachers and paraprofessionals in Colleges of Education in North West Nigeria?
2. What are the procedures of laboratory equipment management practice used by teachers and paraprofessionals in Colleges of Education in North West Nigeria?
3. What are the standard operating procedures recommended in the LPMT for laboratories teacher production used in College of Education in North West Nigeria?
4. How does the personnel management procedure meets the standard recommended in the LPMT for laboratories in Colleges of Education in North West Nigeria?
5. What are the quality assurance techniques used in laboratories of Colleges of Education in North West Nigeria?

Research Hypotheses: The following null hypotheses were tested at 0.05 level of significance:

H₀₁: There are no significant differences in safety protocols of Laboratory Management Practice Template (LPMT) for teachers and paraprofessionals in Colleges of Education in North west Nigeria

H₀₂: There are no significant difference in procedures of laboratory equipment maintenance practice used by teachers and paraprofessionals in Colleges of Education in North west Nigeria

H₀₃: There is no significant difference in standard operating procedures recommended in the LPMT and those used in College of Education in North West Nigeria

H₀₄: The personnel management procedure does not significantly meet that recommended in the LPMT for laboratories in Colleges of Education in North west Nigeria

H₀₅: There is no significant difference in the quality assurance techniques used in laboratories of Colleges of Education in North west Nigeria

Methodology

This study developed and assessed the content of the Laboratory Practice Management Template (LPMT) that would ensure standard laboratory practices in Colleges of Education in North West Nigeria for quality pre-service teacher production. The survey design technique employed for this study was ideal because the study sought to ascertain the condition which prevailed in the areas selected for the study; and more also because the samples have similar characteristics to the larger population for generalization of the outcome.

The population of this study comprised all the twelve (12) Colleges of Educations running the Nigeria Certificate in Education (NCE) programmes in Biology, Physics, Chemistry and integrated science in North western states of Kano, Kaduna, Jigawa, Katsina, Kebbi, Sokoto and Zamfara (N=385). Using the Research Advisers (2006) Table of determining sample size from a given population, and based on randomization and age of institution, four (4; 61%; n=235) states were sampled for the study. Furthermore, all lecturers and laboratory technicians involved in the science courses took part in the study

Instrument used was a researcher-designed Science Laboratory Practice Management Template Questionnaire (SLPMTQ). This was developed, vetted and administered while responses generated were collated and analysed using the Cronbach Alpha statistics that yielded an index of 0.78. This questionnaire, as used in survey research was to ensure responses and opinions of the respondents, who are stakeholders in laboratory use are held sacrosanct. This choice is supported by authorities (John et al., 2006; Smith, et al., 2015) who suggested its use in survey and auditing in an educational institution.

The structured questionnaire was interpreted from means and standard deviation scores using the modified Likert three (3)-point rating scale of Very frequent (Vf), Occasionally (Oc), and Rarely (Rr) after collation of responses from academic and paraprofessionals in the areas of: (a) safety protocols, (b) equipment management, (c) standard operating procedures (SOPs), (d) personnel management, and (f) quality assurance. To determine the face and content validity of the instrument, two (2) copies of the questionnaire were given to professionals in the departments of Biology, Chemistry, Physics and Integrated Science, Yusuf Maitama Sule Federal University of Education, Kano for vetting. Their criticisms and modifications were incorporated into the final draft of the questionnaire to ensure unambiguous presentation.

A pilot study was conducted in College of Education, Azare – Bauchi State in the Northeast geographical region not considered in the study. The same instrument was

administered after an interval of one month on the same participants and results obtained from both first and second responses was used to estimate the instrument's reliability coefficient using the Crombach Alpha statistics that yielded an index of 0.78 was deemed reliable. Upon administration of the questionnaire, results obtained were analysed with descriptive statistics of means and standard deviation on observed responses, and inferential statistics of One-way Analysis of Variance (ANOVA) to test the hypotheses raised for the study. All results were deemed significant at 0.05 alpha level.

Results

Data collected for this study are presented in line with the research questions and appropriately described; while the inferential statistics of One-way ANOVA was used to test the null hypotheses at 0.05 alpha level and presented in tables below.

Research Question 1: What are their safety protocols of Laboratory Practice Management Template (LPMT) for teachers and paraprofessionals in Colleges of Education in North west Nigeria?

Table1: Means and standard deviation of responses on Safety protocols of Laboratory Management Practice Template (LPMT) used in Colleges of Education in North west Nigeria.

Item	Safety protocols	Mean	SD	Interpretation
1	Lab environment is usually assessed for risks	2.468	2.04	Rarely
2	Personal Protective Equipment (PPE) available properly used, and maintained	2.164	0.87	Rarely
3	Emergency procedures (spills, fire, injury posted and understood by all personnel	3.170	0.90	V. Frequently
4	Eyewash stations, safety showers, and fire extinguishers are available and serviceable	2.528	0.63	Occasionally
	Overall Summary of safety protocols in LMPT =	8.424	4.44	Rarely

The result on Table 1 shows a descriptive analysis of the responses safety protocols of Laboratory Management Practice Template (LPMT) for teachers and paraprofessionals in Colleges of Education in North west Nigeria. Results revealed that laboratory environments (2.468 ± 2.04) and personal protective equipment (2.164 ± 0.87) were rarely practiced; while items on emergency procedures (3.170 ± 0.90) and eyewash stations and fire extinguisher availability were very frequently and occasionally practiced respectively. In summary, the overall result obtained indicated that the safety protocols of the LPMT were rarely practiced. In order to find out whether these responses are significant, inferential statistics of One-way ANOVA was used. The results are presented in Table 2.

Null Hypothesis 1: There are no significant differences in safety protocols of Laboratory Management Practice Template (LPMT) for teachers and paraprofessionals in Colleges of Education in North west Nigeria

Table 2: **Summary of ANOVA on the significant differences in safety protocols of Laboratory Management Practice Template (LPMT) for teachers and paraprofessionals in Colleges of Education in North west Nigeria**

Item	Statement	Mean	SD	MSb	MSw	df	Fcrit	Fcal
1	Lab environment is usually assessed for risks	2.468	2.04					
2	Personal Protective Equipment (PPE) available properly used, and maintained	2.164	0.87					
3	Emergency procedures (spills, fire, injury posted and understood by all personnel	3.170	0.90	41.969	1.531	3,936	8.526	15.23* (*Sig)
4	Eyewash stations, safety showers, and fire extinguishers are available and serviceable	2.528	0.63					
	Overall Summary of safety protocols in LMPT	8.424	4.44					

From the results of inferential statistics of One-way ANOVA presented in Table 2, responses of subjects on LPM template in respect of null hypothesis 1 was significant (safety protocols: $F_{(3,936)} = 15.36 > 0.05$).; hence the was not rejected. Result of the analysis showed that safety protocols are in line with the provisions of the LPMT.

Research Question 2: Are there procedures of laboratory equipment management practice used by teachers and paraprofessionals in Colleges of Education in North west Nigeria?

Table 3: **Means and standard deviation of responses on Procedures of laboratory equipment management practice used in Colleges of Education in North west Nigeria.**

Item	Procedures of laboratory practices	Mean	SD	Interpretation
1	There an up-to-date, centralized inventory of all chemicals and biologicals	2.223	2.01	Rarely
2	Hazardous materials are correctly stored according to regulatory guidelines	3.240	0.94	V. Frequently
3	Equipment maintenance and calibration records are current and accessible	1.462	1.24	Rarely
4	Broken or malfunctioning equipment are clearly labeled and removed from service	3.731	0.89	V. Frequently
	Overall Summary of equipment mgt. practice	10.656	5.08	Occasionally

Table 3 reveals the means and standard deviation of responses on procedures of laboratory equipment management practice used in Colleges of Education in North west Nigeria. Results revealed that up-to-date, centralized inventory (2.233 ± 2.01) and equipment

maintenance records (1.462 ± 1.24) are rarely practiced procedures; whereas careful storage of hazardous materials (3.240 ± 0.94) and labelling and removed of malfunctioning equipment from service (3.731 ± 0.89) are also very frequently practiced. Thus, the overall result obtained indicated that the equipment management practice of the LPMT was occasionally practiced.

However, in order to find out whether these responses are significant, inferential statistics of One-way ANOVA was used and the results are presented in Table 4.

Table 4: Inferential statistical analysis of Laboratory Equipment Management Practice

Item	Statement	Mean	SD	MSb	MSw	df	Fcrit	Fcal
1	There an up-to-date, centralized inventory of all chemicals and biologicals	2.223	2.01					
2	Hazardous materials are correctly stored according to regulatory guidelines	3.240	0.94					
3	Equipment maintenance and calibration records are current and accessible	1.462	1.24	243.437	1.814	3,936	8.526	134.19* (*Sig)
4	Broken or malfunctioning equipment are clearly labelled and removed from service	3.731	0.89					
	Overall Summary of equipment mgt. practice	10.656	5.08					

$$F_{(3,936)} = 134.19 > 0.05$$

Results of analysis presented in Table 4 showed that responses in respect of laboratory equipment management practice was significant ($F_{(3,936)} = 134.19 > 0.05$); hence the null hypothesis was not accepted. This implies that equipment in the laboratories is performing their intended functions and contributing to the quality of services being provided.

Research Question 3: What are the standard operating procedures recommended in the LPMT for laboratories teacher production used in College of Education in North West Nigeria?

Table 5: Means and standard deviation of responses on Standard operating procedures (SOPs) recommended in the LPMT for laboratories in College of Education in North West Nigeria

Item	Statement	Mean	SD	Interpretation
1	SOPs are available for all hazardous materials and processes	1.215	1.14	Rarely
2	There are Step-by-step instructions for safe and proper use of all major lab equipment	2.020	1.04	Rarely
3	There are SOPs for documenting all experimental procedures, risks and safety	1.833	0.82	Rarely
4	Schedule for regular internal and external safety audits and inspections are available	1,144	1.31	Rarely
	Overall Summary of SOPs in LPMT	6.212	0.952	Rarely

Means and standard deviation of responses on standard operating procedures in the LPMT as practiced in Colleges of Education in North west Nigeria revealed setting standards for hazardous materials (1.215 ± 1.14), Step-by-step instructions on safe use of equipment (2.020 ± 1.04), documenting all experimental procedures (1.833 ± 0.82) and schedule for regular internal and external audits and inspection (1.144 ± 1.31) were rarely practiced.

In order to find out whether these responses are significant, inferential statistics of One-way ANOVA was used and the results are presented in Table 6.

Table 6: Inferential statistical analysis of ANOVA on Standard Operating Procedure in LPMT

Item	Statement	Mean	SD	MSb	MSw	df	Fcrit	Fcal
1	SOPs are available for all hazardous materials and processes	1.215	1.14					
2	There are Step-by-step instructions for safe and proper use of all major lab equipment	2.020	1.04					
3	There are SOPs for documenting all experimental procedures, risks and safety	1.833	0.82	45.28	11.93	3,936	8.526	26.35*
4	Schedule for regular internal and external safety audits and inspections are available	1,144	1.31					
	Overall Summary of SOPs in LPMT	6.212	0.952					

$$F_{(3,936)} = 26.35 > 0.05$$

Result of One-way ANOVA presented in Table 6 revealed that responses of staff of science laboratories in the area of study on standard operating procedures are significant ($F_{(3,936)} = 26.35 > 0.05$); and consequently, the null hypothesis was rejected. indicating that standards of operation meet the requirement stated in the LPMT

Research Question 4: How does the personnel management procedure meet the standard recommended in the LMPT for laboratories in Colleges of Education in North West Nigeria?

Table 7: Means and standard deviation of responses on Personnel management procedure in the LPMT for laboratories in Colleges of Education in North West Nigeria

Item	Statement	Mean	SD	Interpretation
1	Clear definition of safety responsibilities and reporting hierarchy for all lab members	2.641	0.77	Occasionally
2	Mandatory safety training for all staff before work begins	1.425	2.02	Rarely
3	There is a system of documenting all completed training sessions and approvals	1.831	2.15	Rarely
4	Regular lab meetings to discuss progress, safety concerns, and updates.	2.097	1.02	Occasionally
	Overall Summary of Personnel Mgt Procedure	7.994	1.49	Occasionally

Table 7 showed the descriptive statistics of responses on personnel management procedure practiced in Colleges of Education in North west Nigeria. Mandatory preservice safety training (1.425 2.02), documentation of all training sessions and approvals (1.831±2.15) are rarely practiced; whereas, clear definitions of safety responsibilities (2.641±0.77), and regular meetings in the laboratory to discuss progress and safety updates (2.097±1.02) are occasionally practiced. The implication is that there is no consistency in the practice enshrined in the LPMT among science laboratory staff of Colleges of Education in North west Nigeria. However, in order to find out whether these responses are significant, the inferential statistics of One-way ANOVA was employed. The results are presented in Table 8

Table 8: Inferential statistical analysis on personnel management procedure in LPMT

Item	Statement	Mean	SD	MS b	MSw	df	Fcrit	Fcal
1	Clear definition of safety responsibilities and reporting hierarchy for all lab members	2.641	0.77					
2	Mandatory safety training for all staff before work begins	1.425	2.02					
3	There is a system of documenting all completed training sessions and approvals	1.831	2.15	319.561	2.585	3,936	8.526	123.53*
4	Regular lab meetings to	2.097	1.02					(*Sig)

discuss progress, safety concerns, and updates		
Overall Summary of Personnel Mgt Procedure	7.994	1.49

Result of One-way ANOVA presented in Table 8 on personnel management procedure as practiced in Colleges of Education in North west Nigeria was significant ($F_{(3,936)} = 123.53 > 0.05$); and consequently, the null hypothesis was rejected. indicating that personnel management procedure meet the requirement stated in the LPM Template.

Research Question 5: What are the quality assurance techniques used in laboratories of Colleges of Education in North west Nigeria?

Table 9: Means and standard deviation of responses on Quality Assurance techniques used in laboratories of Colleges of Education in North west Nigeria

Item	Statement	Mean	SD	Interpretation
1	Standardized physical and digital data entry storage, backup, and security available	1.340	1.99	Rarely
2	Standardized procurement process for ordering new equipment, supplies and reagents	3.772	1.05	V. Frequently
3	Waste accumulation areas kept clean and managed safely	3.557	0.88	V. Frequently
4	Maintenance of all documentation, experiment records, changes in protocols and safety reported	3.491	2.07	Occasionally
	Overall Summary of Quality Assurance techniques in LPMT	12.16	5.99	V. Frequently

A critical study of Table 9 showed responses on quality assurance techniques used in laboratories in Colleges of Education in North west Nigeria. It was revealed that there are standardized procurement process for ordering new equipment, supplies and reagents (3.772 ± 1.05), safety protocols are put in place in the management of waste generated (3.557 ± 0.88), and documentation of records and safety records (3.491 ± 2.07) in the laboratory. These practices are carried out very frequently. Thus, the quality assurance aspect of laboratory management practice template was adhered to very frequently.

In order to ascertain whether these responses are significant, the inferential statistics of One-way ANOVA was used for analysis. The results are presented in Table 10.

Table 10: Inferential statistical analysis on Quality Assurance techniques in LPMT

Ite m	Statement	Mea n	SD	MSb	MSw	df	Fcrit	Fcal
1	Standardized physical and digital data entry storage, backup, and security available	1.340	1.99					
2	Standardized procurement process for ordering new equipment, supplies and reagents	3.772	1.05					
3	Waste accumulation areas kept clean and managed safely	3.557	0.88	305.108	2.534	3,936	8.526	134.51*
4	Maintenance of all documentation, experiment records, changes in protocols and safety reported	3.491	2.07					(*Sig)
	Overall Summary of Quality Assurance techniques in LPMT	12.160	5.99					

Result of One-way ANOVA presented in Table 10 on quality assurance technique practiced in Colleges of Education in North west Nigeria was significant ($F_{(3,936)} = 134.51 > 0.05$). The null hypothesis was rejected; indicating that due process was always followed in the procurement of equipment and reagents and other laboratory protocols in compliance with the provisions of the LPM template.

Discussion of Findings

Safety in science laboratories ensures a safe and healthy working environment, prevents accidents and injuries, and maintain the integrity of the research being conducted. According to Occupational Safety and Health Administration (OSHA) (2016), laboratories must implement safety protocols to protect employees from hazards and ensure a safe working environment. The significant null hypothesis in this study indicates that the laboratory's safety protocols are aligned with regulatory requirements and are contributing to the overall safety of laboratory personnel. On equipment management procedures in LPMT, the significant null hypothesis obtained suggests that the laboratory is managing its equipment effectively, and no major changes are needed in this area. According to the International Standards Organization (ISO), (2012), laboratories must implement equipment

management procedures to ensure that equipment is properly maintained and calibrated to produce accurate and reliable test results. The significant null hypothesis result in this study are aligned with international standards and are contributing to the overall quality of laboratory services.

Standard operating procedures (SOPs) are essential for ensuring consistency and efficiency in organizational processes (Smith, et al., 2015). The results of the study indicate a significant null hypothesis on SOPs, suggesting that the implementation of the content of LPMT has a substantial impact on organizational outcomes; these procedures play a crucial role in achieving organizational goals. They not only align principles of Total Quality Management (TQM), they emphasize the importance of standardization in achieving quality and efficiency (Deming, 1996). Furthermore, the responses of this study on laboratory's personnel management procedure was significant. This suggests that the laboratory is managing its personnel effectively, and no major changes are needed in this area. However, it is essential to note that a significant null hypothesis does not necessarily mean that the personnel management procedures are optimal. It is still important to regularly review and evaluate these procedures to ensure they remain effective, relevant and aligned with best practices (Berman, et al., 2013; Ivowi, 2004; Mathis & Jackson, 2011).

Finally, the significant null hypothesis on quality assurance techniques in Laboratory Practice Management (LPM) implies that the current techniques are effective and do not have a significant impact on laboratory practice management. It should, however, be noted that quality assurance is an ongoing process, and management team must continually monitor and evaluate their quality assurance techniques to ensure they remain effective and up-to-date (Westgard, 2013).

Conclusion

From the findings of this study, it can be concluded that majority of science laboratories in Colleges of Education in North west Nigeria are implementing effective practices in safety protocols, equipment management procedures, standard operating procedures, personnel management procedures, and quality assurance techniques. These practices are in line with the content of the laboratory practices management template (LPMT) and are contributing to the overall quality and efficiency of laboratory

Recommendations

1. There is need for regular review and update of safety protocols to ensure they remain effective and compliant with regulatory requirements.
2. Authorities should ensure periodic maintenance of equipment to ensure accuracy and reliability of experiment undertaken in the laboratories.
3. The standard operating procedures in the science laboratories need to be regularly reviewed and updated to ensure they remain effective and aligned with best practices.
4. Continue to implement and maintain effective personnel management procedures to ensure that laboratory personnel are trained and competent to perform their duties.

5. Management and stakeholders should uphold the tenets of effective quality assurance techniques to prevent supply fake equipment and reagents in the laboratories.



Acknowledgements

The authors appreciate the Tertiary Education Trust Fund (**TETFUND**) for providing funds to carry out this research work; the heads of departments of sampled institutions, for consenting to data collection in their domains and all the field workers in the sampled zones, for administering and retrieving questionnaire used for the study.

References

- Ajewole, A. M. Ogini & Okedeyi A. S. (2013) Management Of Resources For Science, Technology And Mathematics Education: Problems And Forward. *Journal of the Science Teacher Association of Nigeria* 47th Edition
- Balogun, T.A. (2006) Improvisation Of School Science Teaching Equipment, *J. STAN* 12(2) 152 – 158.
- Berman, E. M., Bowman, J. S., West, J. P., & Van Wart, M. R. (2013). Human resource management in public service: Paradoxes, processes, and problems. Sage Publications.
- Deming, W. E. (1996). Out of the crisis. Cambridge, MA: MIT Press.
- Eniayeju, P. A. (2009) “Conducive Classroom Environment For Science, Technology And Mathematics (STM) Education: Infrastructural Facilities For Effective Teaching Aid Learning”. A Paper Presented At Science Teachers Association Seminar.
- Gwamanja S. T. (1990): Methods Of Science Teaching P.H. Tojan Press.
- ISO 15189. (2012). Medical laboratories - Requirements for quality and competence. International Organization for Standardization.
- Iwovi, U. M. O. (2004) Science, Mathematics And Information Technology Challenges To National Development Akoka *Journal of Pure Applied Science Education*. 5 (1) Pg. 9 – 14.
- Jegede, O. J. (2000), “The Potential of Science Technology and Society Course. In Technology Education and The Quality of Life”. *Journal Of Science Teacher Education*, Vol. 5.
- John, C. Smoll, T. & Kinderball, T, S, (2006). Laboratory Manual For Schools And Colleges Heinemann Educational Books Limited, London.

- Mani, T. O. (2003), The School Laboratory Ahmadu Bello University, Zaria, Unpublished Handbook.
- Mathis, R. L., & Jackson, J. H. (2011). Human resource management. Cengage Learning.
- National Commission for Colleges Of Education (2012), Minimum Standard In Science For All Nigerian Colleges Of Education. Abuja: Govt Press
- Occupational Safety & Health Administration (OSHA). (2016). Laboratory Safety Guidance. U.S. Department of Labor.
- Oladimeji, G. A. D. (2013). Improvisation In Biology Learning, J. STAN 19(3) 32 – 39.
- Onwuegbuze, Ann E.; Anthony J. Witcher; Qun G. Jiao; Kathleen M. T.; Collins, Terry L. James & Lynn C. Minor (2018). Standard Laboratory techniques. <https://ites/download>
- Research Advisers (2006). Determining Sample Size. Research Advisers, 1(1), 1- 4
- Smith, J., Johnson, K., & Davis, K. (2015). The impact of standard operating procedures on organizational performance. *Journal of Management Studies*, 52(3), 345-362. doi: 10.1111/joms.12101
- Walberg, H. J. (2011), Improving School Science in Advanced and Developing Countries *Review of Educational Research*, Vol. 77, 25 – 69.
- Westgard, J. O. (2013). Quality management in clinical laboratories. *Clinics in Laboratory Medicine*, 33 (1), 1-13. doi: 10.1016/j.cll.2012.11.001