African Journal of Educational Studies in Mathematics and Sciences Vol. 19, No. 2. 2023

Levels of Compliance to Science Laboratory Safety Procedures and Practices in Secondary Schools in Tanzania

Ntulo Alten[1], John Jasson[1] and Kimaro Aurelia[2]

Abstract

This study investigated the levels of compliance to laboratory safety procedures and practices in secondary schools in Tanzania and explored the influence of schools' performance rankings (based on the Presidential Award on Environmental Conservation (PAEC) evaluation) on their assessed levels of compliance to laboratory safety procedures and practices. The study was a cross-sectional survey design that employed a checklist to obtain data. Fifty-nine schools with all three PAEC rankings, best, moderate and unsatisfactory, were randomly sampled from across districts/councils in the target regions. Data were collected using a checklist adapted from Safety in Science Laboratories Hand Book, which was completed by a laboratory technician or head of science department from each school. The results show that 95% of the schools with unsatisfactory compliance level improved on their PAEC ranking level suggesting the competition had the greatest impact on this category of schools. But the fact that 23% of the schools dropped from their earlier PAEC ranking level should be a matter of concern to all stakeholders in science education in the country. A one-way analysis of variance test carried out to test whether or not the differences among the schools' assessed compliance mean scores were statistically significant showed that the mean of the moderate compliance schools (M = 61.1, SD = 12.07) was significantly higher than those obtained by the schools in the other two compliance levels (best and unsatisfactory) combined (M = 50.9, SD = 19.97), (M = 49.2, SD = 11.52); F (3, 56) = 3.619, p = .033. These results suggest that 3 years after the PAEC initiative, many schools ranked as having unsatisfactory compliance have improved to moderate but several ranked as having best compliance have declined to the unsatisfactory compliance level. Recommendations are made to ensure compliance to laboratory safety procedures and practices by all schools are taken more seriously by all stakeholders.

Keywords: laboratory safety management; laboratory safety practices; laboratory safety procedures; science laboratory; secondary school laboratory

Introduction

Tanzania adapted the competence-based curriculum for all levels of secondary schools between 2004 and 2010 (United Republic of Tanzania (URT), 2010). The new curriculum intended to improve education quality and equity through Secondary Education Development Program (SEDP). Scientific investigation using appropriate methods and technology to generate relevant scientific information was emphasized. Three laboratories that include physics, chemistry and biology subjects were made compulsory for the establishment of secondary school (URT, 2010). The secondary education became the basic education for all (URT,

[1]Ntulo Alten, Department of Zoology and Wildlife Conservation, College of Natural and Applied Sciences, University of Dar es Salaam. Email: altenmbeta@yahoo.co.uk

[1]John Jasson, Department of Zoology and Wildlife Conservation, College of Natural and Applied Sciences, University of Dar es Salaam. Email: wildornithology@udsm.ac.tz

[2] Kimaro Aurelia, Department of Educational Psychology and Curriculum Studies School of Education, University of Dar es Salaam. Email: aurekimaro@gmail.com

 DOI: https://dx.doi.org/10.4314/ajesms.v19i1.10

2014). This led to an increase in number of schools and enrollment and increase in number of laboratories and learning activities. This can be evidenced by the increase in secondary schools from 4,773 in 2016 to 5001 in 2019 and the increase in enrollment of students by 8.8% in the same period of time (URT, 2019). The trend in improving education quality and equity calls for the concern in laboratory procedures and safety issues that are potential to a hazard (Omebe, 2010). Although no laboratory safety case/accident has been reported by the government and scholars, more than twenty secondary schools were burnt between 1994 and 2017 resulting in death and injuries to students (Bushesha and Ndibalema, 2017). The immediate reported causes are indiscipline and riots among students, the use of kerosene lamps and candles for studying during night and electric faults (Nyagawa, 2018).

From 2003 to date the country took two main directions that are considered to be independent of each other. The first being general health and safety legislation and the second being the integration of safety and health issues in the school curricular. Starting with general legislation, in 2003 Tanzania enacted the Occupational Health and Safety Act that repealed the Factories and Ordinance Act of 1950 to make provisions for the safety, health and welfare of persons at work in factories and other places of work. This was after the establishment of Occupational Safety and Health Authority (OSHA) under the Executive Agency Act No. 30 of 1997 that was officially launched in 2001. Like the Occupational Health and Safety Act of 2003, the aim of the agency is to improve the health and safety of workers at all workplaces through enforcement and promotion of occupational health and safety practices. It provides also for protection of the persons other than persons at work against hazards to health and safety arising out or in connection with activities of persons at work (URT, 2003a). In the same year (2003) the government of Tanzania enacted the Industrial and Consumer Chemicals Act to provide for the management and control of production, importation, transportation, exportation, dealing and disposal of chemicals (URT, 2003b). Although no legislation for its implementation has been enacted, in 2009 Tanzania formulated the National Occupational Health and Safety Policy. This was for the promotion of occupational health and safety that encompasses provision and maintenance at the highest degree of safety and healthy working conditions and environment as a prerequisite for the facilitation of optimal social, mental and physical wellbeing of workers at workplaces as well as safety of property (URT, 2009).

For the integrated safety and health issues in school curricular, the competence-based curricular consists little emphasis on safety issues for secondary schools and their laboratories. For example, in ordinary level physics syllabus, the introduction to laboratory practices contains laboratory rules and safety as subtopic. The specific objective includes students to explain the safety measures in physics laboratory, use the first aid kit to render first aid and identify and use warning signs (URT, 2007a). In the chemistry syllabus, the laboratory techniques and safety include rules and safety precautions in a chemistry laboratory; and first aid are treated as separate subtopics (URT, 2007b) while in the biology syllabus, the safety in our environment comprising first aid; safety at home and school; and waste disposal are also incorporated as subtopics (URT, 2005).

Despite the trends in taking safety initiatives in Tanzania, much is still needed especially in schools for example the newly formulated Tanzania National Occupational Health and Safety Policy has not been extended to include

schools and pupils. Like the majority of other countries, Tanzania use Occupational Safety and Health Act (OSHA) and other safety legislations for the employees and employers for provision of a safe health working environment (Kataoka et al., 2016). These legislations do not account for the safety of school pupils despite their exposure to laboratories and other hazardous learning environment on daily basis (Walter, et al., 2017). The checklist for schools in the Presidential Award on Environmental Conservation (PAEC) competition does not include school laboratories. It only includes the general safety concerns of school buildings, surroundings, classrooms, kitchen, dormitories, store, dining hall, parking, play grounds, vector and vermin control, water supply, power supply and sewerage and drainage (URT, 2018). For the school curriculum, the most common thing in physics, chemistry and biology syllabi of Tanzania is the indication of charts and drawings as the teaching/learning materials which does not reflect competence-based. The curricular/syllabi are silent on the setting/composition of the laboratories on safety procedures and practices except for the first aid. This could in turn affect the hazard response for quality education as one of the categories of the year 2030 education for sustainable development implementation process (Yamey, et al., 2014).

Experience from industrialized countries shows that the overall occupational safety accidents are slowly declining (ILO, 2003) while increasing in developing countries (Alli, 2008). In Nepal for example 47% of respondents from secondary school chemistry laboratories in 2017 experienced accidents due to safety issues (Kandel, 2017). Also, there have been substantial injuries and deaths in the recent past due to accidents in academic laboratories globally (Menard and Trant, 2019). Moreover, the rate of accidents at university laboratories globally is reported to be 10 to 50 times higher than industrial laboratories (Groso, et al., 2012). Therefore, due to the observed safety practices standards, policies and legislation drawbacks, little emphasis of safety issues in schools and their laboratories in the school curricular raises a question to whether or not there is compliance to science laboratory safety procedures and practices in schools. The answer to such a question is important in understanding on whether there is sufficient information given to students during competency-based curriculum teaching/learning on safety issues, procedures and practices (Mugivhisa, 2021).

The reported school fires that caused death, injuries and loss of property in secondary schools in Tanzania plus the experience of increasing secondary school laboratories leading into increase laboratory accidents globally signifies the importance of this study. For these reasons, it becomes important to study the compliance of science laboratory safety procedures and practices in Tanzania schools through looking at the quality of school laboratories, laboratory technicians/ heads of science subjects, availability of laboratory safety facilities and systems, written procedures for safety practices in school laboratories, training and compliance to laboratory safety procedures and practices and emergence preparedness and response for safety issues in school laboratories using the standard checklist as per adapted Safety in Science Laboratories Hand Book by Education Bureau (2013) that is more comprehensive for establishment of baseline information. Such information can be used as a baseline to improve safety and practices in school laboratories and by so doing enhance the quality of science education.

Purpose of Study and Research Questions

For these reasons, it becomes important to study secondary schools' compliance to science laboratory safety procedures and practices in Tanzania by examining the

availability and quality of laboratories, safety facilities and systems, implementation of safety practices, and training in laboratory safety procedures and practices. Specifically, the study was guided by the following research questions:

1. What are the levels of compliance to laboratory safety procedures and practices in secondary schools in Tanzania?
2. What is the influence of schools' performance rankings (based on the Presidential Award on Environmental Conservation (PAEC) evaluation categories) on their levels of compliance to laboratory safety procedures and practices?

Methodology

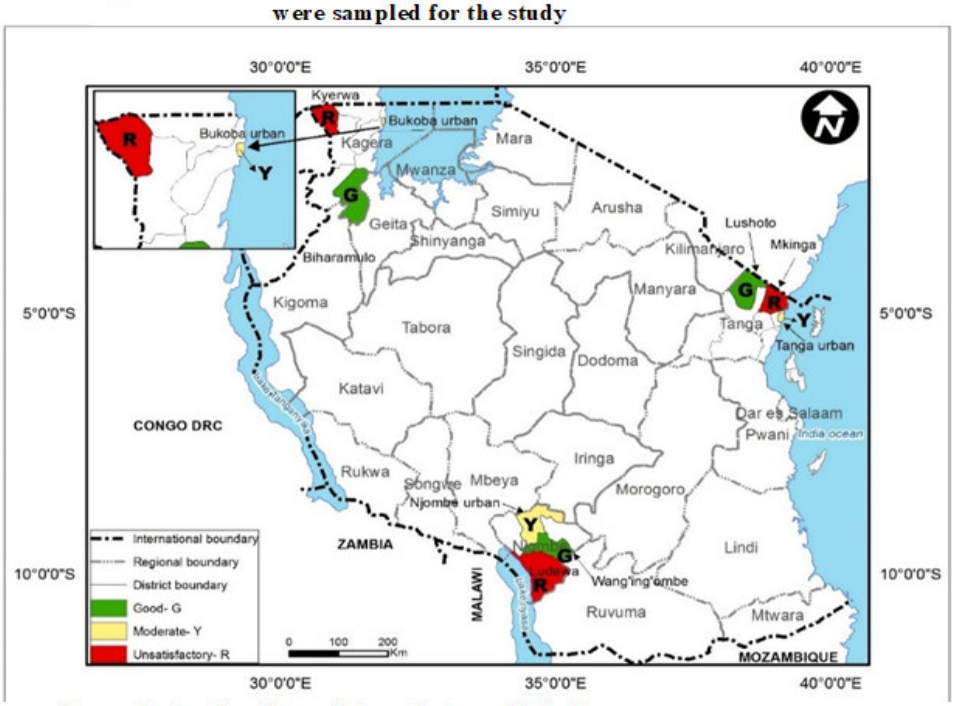
Research Design

The study was a cross-sectional survey design that employed a checklist to obtain data from laboratory technicians and heads of science departments. The checklist was adapted from Safety in Science Laboratories Hand Book (Education Bureau, 2013). The quantitative research design was used in order to achieve a more comprehensive understanding on the magnitude of the challenges in ensuring schools' compliance to science laboratory safety procedures and practices.

Population and Sampling

The population consisted of all secondary schools in Tanzania and three regions - Njombe, Tanga and Kagera – constituted the target population involved in this study based on their performance in the 2018 Presidential Award on Environmental Conservation (PAEC) (United Republic of Tanzania (URT), 2018). Although the 2018 PAEC Performance Report did not give specific information for the status of safety, health and environmental component, Njombe was ranked best, Tanga was ranked moderate and Kagera was ranked unsatisfactory. Figure 1 shows the location of the three regions involved in the study.

Figure 1 **The three Regions of Tanzania where Districts/Councils were sampled for the study**



(Source: University of Dar es Salaam, Cartographic Unit)

A multistage sampling procedure was used in selecting the schools that participated in the study. In the first stage, districts/councils categorized as best, moderate and unsatisfactory, based on the PAEC evaluation criteria, were purposefully selected from the three regions. In the second stage, stratified random sampling was used to pick schools for the study due to their heterogeneity in the area of jurisdiction. Schools categorized as best, moderate and unsatisfactory, based on compliance to areas in the PAEC evaluation criteria, were randomly sampled from each district/council due to their heterogeneity in the area of jurisdiction. The sample size was determined by (n. Pi) as described by Kothari (2004) whereby Pi is the representative proportion of population included in stratum i and n is the sample size. Each council constituted at least 20% secondary schools making the total sample of 59 schools both having science subjects (physics, chemistry and biology). Table 1 presents the distribution of schools in councils/districts sampled from the three regions involved in the study.

Table 1 Distribution of schools in councils/districts sampled from the three regions involved in the study

Region	PAEC[1] Performance Levels of Schools in Districts			**Total**	
	Best	Moderate	Unsatis-factory	**Number**	**Percent**
Njombe region	4	3	6	13	22
Tanga	11	13	3	27	46
Kagera	6	7	6	19	32
	24	20	15	59	100

[1]PAEC Is the performance level based on the government's Presidential Award on Environmental Conservation (see (URT, 2018).

Table 1 shows that three regions with performance ranking best, moderate and unsatisfactory were first selected, then three districts/councils were selected from each region making a total of nine councils. The number of schools selected from each council of the ranking categories in each council depended on the number of schools in each category in the council. From each secondary school one laboratory technician/head of science department was selected as respondent.

Data Collection and Analysis

Data was collected by a checklist which was completed by a laboratory technician or head of science department from each school in the sample. The checklist comprised five major sections comprising (i) demographic characteristics of laboratory technician; (ii) availability of laboratory safety facilities and systems, (iii) availability of safety management guide(s), and implementation of safety management practices, (iv) the training and compliance to laboratory safety procedures and practices; and (v) the emergency preparedness to respond to safety issues.

The data obtained from the checklist were keyed into the SPSS version 20 software which was subsequently used for the analysis. A major independent variable of the study, designated "*schools' compliance to laboratory safety procedures and practices*", was defined in terms of the sum of scores obtained for items under the following three

sections of the checklist: laboratory safety facilities and systems availability; safety management practices implementation; and emergency preparedness to respond to issues. The overall mean for these three variables was used as a proxy score for the schools' compliance to laboratory safety procedures and practices. The computed composite mean scores for "compliance" were recoded into three performance levels or categories using the criteria – obtaining less than 40%, obtaining 40% to 74.9%, and obtaining 75% and over – as having unsatisfactory, moderate and best compliance, respectively. The schools' composite percent mean scores and compliance levels were used with descriptive statistics to address the research questions in the sections that follow.

Results and Discussion

Demographic Variables of Teachers

Table 2 shows the demographic characteristics of the science teachers (or educators) and the laboratory technicians who participated in the study. Since only one participant was made to complete the survey instrument in each school, the teachers and laboratory technicians in the fifty-nine schools sampled (see Table 1) were involved in this evaluation study. They comprise 47 (80%) males and 12 (20%) females with only 20% being older than 35 years.

Out of the 59 participants 44 representing, 75% were science teachers/educators while the remaining 15 (25%) were laboratory technicians. Majority of the participants do

Table 2 Demographic characteristics of the study participants

	Frequency	Percent		Frequency	Percent
Respondent Age			*Year of Form 6 completion*		
Not older than 35 years	47	79.7	2010 or before	30	50.8
Older than 35 years	12	20.3	After 2010	29	49.2
Total	59	100	Total	59	100
Respondent Sex			*Experience in working in science laboratory*		
Male	47	79.7	Has ≤12 years lab experience	48	81.4
Female	12	20.3	Has >12 years lab experience	11	18.6
Total	59	100	Total	59	100
Highest level of education			*Trained in Environmental Management*		
Holds Diploma or Form 6 cert.	22	37.3	Yes	26	44.1
Holds Bachelor/Master degree	37	62.7	No	33	55.9
Total	59	100	Total	59	100
Respondent Profession			*Trained on Emergency Preparedness*		
Science Educator	44	74.6	Yes	31	52.5
Laboratory technician	15	25.4	No	28	47.5
Total	59	100	Total	59	100

not have much experience in working in science laboratories as 48 (81%) indicated they do not have more than 12 years working experience. Nevertheless, the majority 37 (63%) hold Bachelor and/or Masters degrees with 22 (37%) having diplomas or Form 6 certificate.

What are the levels of compliance to laboratory safety procedures and practices (LSPP) in secondary schools in Tanzania?

The question requires that we examine how the proportion of schools in the regions in the three PAEC categories are changing or to describe how much progress had been made in schools' levels of compliance to laboratory safety procedures and practices (LSPP) since the PAEC evaluation. Table 3 shows the PAEC ranking and the assessed levels of compliance yielded by the data provided by the lab technicians in this study.

At the onset the present study a little under half of the schools (i.e., 46%) were at the moderate compliance level on the PAEC evaluation criteria, and the proportions that were at the best and unsatisfactory levels were 22% and 32% respectively. However, three years after the Presidential Award on Environmental Conservation (PAEC) competition, the proportion reaching the moderate compliance level had tremendously increased to 78%. Table 3 also shows a 24% reduction in the proportion of schools improving their compliance levels from unsatisfactory to moderate, but 15% decrease in schools at the best compliance level.

Table 3 PAEC Ranking and Assessed Compliance Levels of Selected Secondary Schools in Tanzania

Compliance Level	PAEC Ranking		Assessed Level	
	Number of Schools	Percent (%)	Number of Schools	Percent (%)
Best	13	22	7	12
Moderate	27	46	46	78
Unsatisfactory	19	32	6	10
	59	100	59	100

Figure 2 Percentage of Schools at PAEC Ranking and Assessed Compliance levels

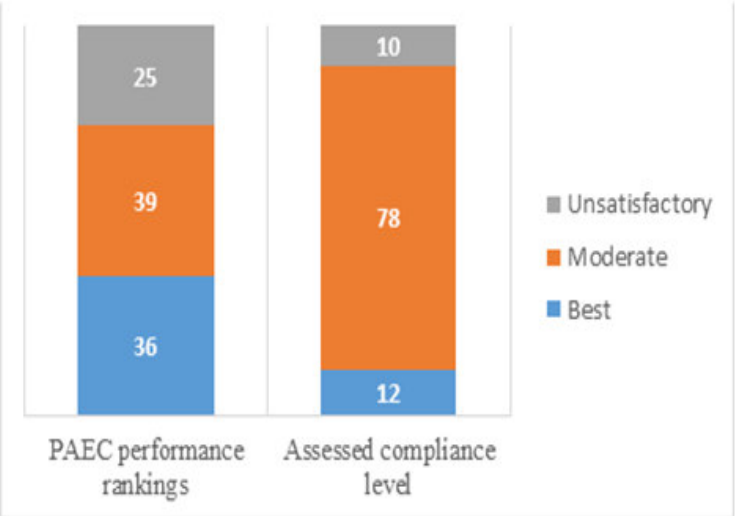


Figure 2 illustrates the proportion schools at the PAEC compliance levels and the levels assessed for the selected secondary schools in this study. The assessed compliance levels in this study, as can be seen in the figure, indicate a substantial reduction in the proportion of schools with unsatisfactory compliance to LSPP

leading to a massive increase in proportion of schools with moderate compliance.

But the data shows the compliance level of some schools dropped from best to unsatisfactory. It is interesting to note that two of the schools which were ranked best during the PAEC have dropped 2 levels below the PAEC ranking and as many as nine schools have dropped form best to moderate level of compliance (see Table 4).

What is the influence of schools' performance rankings (based on PAEC evaluation category) on their assessed levels of compliance to LSPP?

The second research question sought to find out the influence of the schools' PAEC performance rankings on their compliance to laboratory safety procedures and practices (LSPP) assessed in the current study 3 years after the PAEC initiative. As explained above, the schools' scores on the three variables and overall mean for the variables were computed to explore the influence of the schools' PAEC performance rankings on their compliance to laboratory safety procedures and practices. Table 5 shows the descriptive statistics of the schools' scores on the three variables and overall mean compliance scores.

Table 4 Changes in compliance levels as indicated by the Lab Technicians' Responses

Progress on PAEC Ranking	**Assessed Compliance Levels**			**Row Total**
	Unsatisfactory	Moderate	Best	
Moved 1 Level Up the PAEC Ranking	18 (95)[1]	5 (19)	0 (0)	23 (39)
Kept Level on the PAEC Ranking	1 (5)	19 (70)	2 (15)	22 (37)
Dropped 1 Level Below PAEC Ranking	0 (0)	3 (11)	9 (69)	12 (20)
Dropped 2 Levels Below PAEC Ranking	0 (0)	0 (0)	2 (15)	2 (3)
Total	19 (100)	27 (100)	13 (100)	59 (100)

[1]Level (or column) percentages in parenthesis

The results show that 95% of the schools with unsatisfactory compliance level improved or moved one level up the PAEC ranking suggesting the competition had the greatest impact on this category of schools.

But the fact that the Lab Technicians' responses indicate 23% of the schools dropped from their earlier PAEC ranking should be a matter of concern to all stakeholders in science education in the country.

Table 5 Descriptive statistics of the schools' assessed mean compliance scores on the variables and overall mean compliance scores

PAEC compliance level on variable	N	Mean	Std. Deviation
Laboratory safety facilities and systems availability			
Best	21	46	25.3
Moderate	23	55	24.1
Unsatisfactory	15	39	23.1
Total	59	48	24.6
Safety management practices implementation			
Best	21	60	27.5
Moderate	23	76	19.9
Unsatisfactory	15	73	18.9
Total	59	69	23.4
Availability and use of laboratory management guide			
Best	21	47	26.6
Moderate	23	53	19.1
Unsatisfactory	15	35	21.1
Total	59	46	23.3
Overall Mean compliance to laboratory safety procedures and practices			
Best	21	51	20.0
Moderate	23	61	12.1
Unsatisfactory	15	49	11.5
Total	59	54	15.9

From Table 5, it will be observed that except for the overall mean, the mean scores of the assessed compliance levels (i.e., best, moderate and unsatisfactory) are very close.

To ascertain whether or not the differences observed in the means are statistically significant, a one-way analysis of variance test was carried out to test the null hypothesis that there is no statistically significant difference among the assessed compliance mean scores. The results for the three variable were found not significant. But the results of their composite mean scores or overall mean compliance scores, presented in Table 6, was found to be significant and reported.

From Table 6, the overall mean scores obtained by the moderate compliance schools (M = 61.1, SD = 12.07) is significantly higher than those obtained by the schools in the other two compliance levels (best and

Table 6 Results of ANOVA on schools' overall mean compliance scores

	Sum of Squares	df	F	Sig.
Between Groups	1685.7	2	3.619	0.033*
Within Groups	13040.7	56		
Total	14726.4	58		

*Significant at $p < 0.05$

unsatisfactory) combined (M = 50.9, SD = 19.97), (M = 49.2, SD = 11.52); F (3, 56) = 3.619, p = .033. Specifically, these results suggest that 3 years after the PAEC initiative, schools ranked as moderate compliance schools in the PAEC evaluation are doing better in their compliance to laboratory safety procedures and practices than schools in the other two levels.

Furthermore, the researchers explored the influence of the respondents' demographic characteristics (see Table 2) on the three variables and the overall mean compliance scores. The independent t-test ran for the differences in the categories of respondents' school mean compliance scores showed two out of the eight demographic characteristics, i.e., education level and profession, yielded statistically significant results. Table 7 shows the independent t-test results of schools' mean compliance scores by respondents' education level and profession.

Table 7 **Independent t-test results of schools' mean compliance scores by respondent's education level and profession**

Variable/Categories	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Education level by laboratory safety facilities and systems availability						
Diploma/Form 6 cert.	22	56.3	25.17	2.126	57	0.038
Bachelor/Master degree	37	42.6	23.12	2.080	41.297	0.044
Education level by safety management practices implementation						
Diploma or Form 6 cert.	22	77.9	22.63	2.234	57	0.029
Bachelor/Master degree	37	64.3	22.69	2.235	44.357	0.030
Respondent profession by availability and use of laboratory management guide						
Science Educator	44	42.5	22.37	-2.183	57	0.033
Laboratory technician	15	57.3	23.26	-2.140	23.458	0.043
Respondent profession by mean overall compliance						
Science Educator/teacher	44	52.1	15.10	-2.018	57	0.048
Laboratory technician	15	61.4	16.79	-1.913	22.230	0.069

The mean availability of laboratory safety facilities and systems scores obtained by respondents who hold diploma or certificate (M = 56.3, SD = 25.17) is significantly higher than the mean score of the Bachelor/Master's degree holders (M = 42.6, SD = 23.12); t (57) = 2.126, p = 0.038. Similarly, the mean safety management practices implementation scores obtained by respondents who hold diploma or certificate is significantly higher than the that of the Bachelor/Master degree holders. Suggesting the diploma or certificate holders rated their schools' laboratory safety facilities and systems as more available than the graduate teachers, and rated their capacity to implement laboratory safety management practices higher than the graduate teachers. With regard to the respondents' profession, science teachers rated the availability and use of laboratory management guides as well as their overall compliance to laboratory safety procedures and practices lower than the laboratory technicians.

Conclusion and Recommendations

PAEC was established to promote sustainable development in the country. Safety, health, environment and sustainable development are interrelated. They have the same objective and

deal with the same issues which are consistent welfare and wellbeing of human being (Molamohamadi and Ismail, 2014). The performance of each depends on the sustainability behavior of the people (Najera, et al., 2010) and the sustainability of behavior depends on education and training (Von Frantzius, 2004). The present study investigated the levels of compliance to laboratory safety procedures and practices in secondary schools in Tanzania to explore how it is influenced by schools' PAEC performance. It was found that 95% of the schools with unsatisfactory compliance level improved on their PAEC ranking level suggesting the competition had the greatest impact on this category of schools. Nevertheless, 23% of the schools at best compliance level dropped from their earlier PAEC ranking level to the lowest level. These results suggest that 3 years after the PAEC initiative, many schools are waking up to their responsibilities for ensuring best compliance to laboratory safety procedures and practices.

Therefore, this study offers the scholarly baseline data for the government of Tanzania and other studies for enhancement of laboratory procedures, practices and safety issues in secondary schools. The government of Tanzania is advised to formulate harmonious laboratory safety guidelines by involving all stakeholders for safety in schools and ensure that laboratories have competent personnel and all safety requirements for both teaching monitoring and evaluating safety-harmonized laboratory curriculum. It should also ensure the guidelines integrate the relevant articles from OSHA, safety integrated curriculum and others aligning to the UNESCO (1994) standards. Finally, the harmonious laboratory safety guidelines can also be integrated into the PAEC checklist for schools to enhance the quality of the competition. Future studies should look at establishing the status on the number of infections, incidences and accidents including their impact in secondary school laboratories to establish the baseline data for future monitoring and assessment or evaluation.

Acknowledgements

Authors would like to thank the University of Dar es Salaam as the facilitator of this study. The authors would also like to thank the Mission Academy of University of Hamburg in Germany for hosting exposure trip and thesis writing scholarship to the first author.

References

Alli, B., (2008). Fundamental principles of occupational health and safety. International Labour Organization, Geneva.

Bushesha, M.S. and Ndibalema, A., (2017). Towards Sustainable Disaster Management: An Assessment of Levels of Community Awareness on Fire Outbreaks and Safety among Public Universities in Tanzania. Huria. Journal of the Open University of Tanzania 24(1): 74-91.

Education Bureau, (2013) Safety in Science Laboratories Hand Book Hong Kong, China.

Groso, A., Ouedraogo, A. and Meyer, T., (2012). Risk analysis in research environment. Journal of Risk Research, 15(2), 187-208.

ILO standards-related activities in the area of occupational safety and health, (2003). Report VI, International Labour Conference, 91st Session. Available at: http://www.ilo.org/public/english/protection/safework/integrap/survindex.htm on 20/2/2022.

Juárez Nájera, M. (2010). Sustainability in Higher Education: An explorative approach on sustainable behavior in two universities. Available at:

https://repub.eur.nl/pub/19411/MJN%20PhD%20Thesis.pdf on 20/2/2022.

Kandel, K.P., Neupane, B.B. and Giri, B., (2017). Status of chemistry lab safety in Nepal. PLOS ONE, 12(6), p.e0179104.

Kataoka, M., Miyagawa, M., Fuji, S., Ito, H., Tanioka, T., Yasuhara, Y., ... & Locsin, R. (2016). Characteristics of Psychiatric Hospital Work Environment Found Attractive by Professional Nurse Administrators in Japan. International Journal of Nursing & Clinical Practices, 3(207), 1-9.

Kothari, C.R., (2004). Research methodology: Methods and techniques. New Age International.

Ménard, A.D. and Trant, J.F., (2020). A review and critique of academic lab safety research. Nature chemistry, 12(1), 17-25.

Molamohamadi, Z. and Ismail, N., (2014). The relationship between occupational safety, health, and environment, and sustainable development: A review and critique. International Journal of Innovation, Management and Technology, 5(3), 198-202.

Mugivhisa, L.L., Baloyi, K. and Oluwole Olowoyo, J., (2021). Adherence to safety practices and risks associated with toxic chemicals in the research and postgraduate laboratories at Sefako Makgatho Health Sciences University, Pretoria, South Africa. African Journal of Science, Technology, Innovation and Development, 13(6), 747-756.

Nyagawa, Z.M., (2018). An investigation of the immediate causes of fire disasters in boarding secondary schools in Tanzania. European Journal of Education Studies, 3(12), 473-489.

Omebe, C.A., (2010). Status of Safety Precautions in Science Laboratories in Enugu State, Nigeria. Annals of Modern Education, 2(1), 101-108.

Sheppard, C. (2020). Integration of laboratory safety and green chemistry: Implementation in a sophomore seminar and an advanced organic laboratory. Journal of Chemical Education, 98(1), 78-83.

United Nations Education Scientific and Cultural Organization-United Nations Environment Program (UNESCO-UNEP).(1994). "International Education Programme". Procedures for developing an Environmental Education Curriculum; https://unesdoc.unesco.org/ark:/48223/pf0000130454

URT, (2003a). The occupation health and safety Act. Government Printer: Dar es Salaam, Tanzania.

URT, (2003b). The industrial and consumer chemicals (Management and Control) Act. Government Printer: Dar es Salaam, Tanzania.

URT, (2004). Tanzania Environmental Management Act of 2004. Government Printer: Dar es Salaam, Tanzania.

URT, (2005). Biology syllabus for secondary education form i – iv. Tanzania Institute of Education, Dar es Salaam, Tanzania.

URT, (2006). School inspection guiding book. Ministry of education and vocational training, Dar es Salaam, Tanzania.

URT, (2007a). Physics syllabus for secondary education form i – iv. Tanzania Institute of Education, Dar es Salaam, Tanzania.

URT, (2007b). Chemistry syllabus for secondary education form i – iv. Tanzania Institute of Education, Dar es Salaam, Tanzania.

URT, (2009). National Occupational Health and Safety Policy. Government Printer: Dar es Salaam, Tanzania.

URT, (2010). Environmental and social management framework. Ministry of education and vocational training, Dar es Salaam, Tanzania.

URT, (2013). Guidelines for management of hazardous waste. Vice President Office, Dar es Salaam, Tanzania.

URT, (2014). Education and training policy. Government Printer: Dar es Salaam, Tanzania.

URT, (2017). School quality assurance handbook. Ministry of Education Science and Technology. Dodoma, Tanzania.

URT, (2018). Presidential Award on Environmental Conservation Report-2018. Government Printer: Dar es Salaam, Tanzania.

URT, (2019). Education sector performance report. Government Printer: Dar es Salaam.

Von Frantzius, I. (2004). World Summit on Sustainable Development Johannesburg 2002: A critical analysis and assessment of the outcomes. Environmental Politics, 13(2), 467-473.

Walters, A.U., Lawrence, W. and Jalsa, N.K., 2017. Chemical laboratory safety awareness, attitudes and practices of tertiary students. Safety science, 96, 161-171.

Yamey, G., Shretta, R., & Binka, F. N. (2014). The 2030 sustainable development goal for health. BMJ, 349.