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EXTENT OF IMPLEMENTATION OF SAFETY PRACTICES IN BIOLOGY LABORATORY AMONG SENIOR SECONDARY SCHOOL STUDENTS IN ENUGU SOUTH LOCAL GOVERNMENT

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ABSTRACT

The study investigated the extent of implementation of safety practices among senior Secondary Schools in Enugu South Local Government Area of Enugu State. Four research questions guided the study. The design of the study was a descriptive survey research. The area of the study is Enugu South Local Government Area. The population of the study consisted 256,480 students and 11,117 Biology teachers.75 Biology students and 25 Biology teachers were sampled. The instrument used for data collection was a structured questionnaire developed by the researchers titled Extent of Implementation of Safety Practices in Biology Laboratory Questionnaire (EISPBQ). The findings revealed that elements of laboratory design, safety equipment availability, and laboratory assistance showed moderate compliance, significant deficiencies persist. Poor laboratory isolation, inadequate safety materials, unqualified personnel, and weak enforcement of safety rules collectively undermine safety standards. The low level of students' adherence to safety practices further exacerbates risks, indicating an urgent need for improved facilities, adequate resources, trained personnel, and stricter enforcement of safety regulations. From the findings conclusions and recommendations were made.

Keywords: Biology Laboratory, Design and Implementation

Introduction

The Biology laboratory is an indispensable component of science education, providing students with hands-on experiences that bridge theoretical knowledge and practical application. According to Olatunde and Adebayo Biology laboratory involves general designs and fittings of Biology laboratories relevant to safety. The authors further averred that the physical design and fittings of a Biology laboratory are foundational to its safety. A well-designed laboratory should include adequate ventilation systems, proper lighting, and fire-resistant surfaces, clearly marked emergency exits, and strategically placed eyewash stations and safety showers (Olatunde & Adebayo, 2021). According to Adeyemi and Olarewaju (2023), many secondary school Biology laboratories in developing countries fail to meet minimum safety design standards. Their study across thirty secondary schools in Oyo State, Nigeria, revealed that only 34% of Biology laboratories had functioning fume hoods, and fewer than 45% possessed properly designed chemical storage facilities that segregated incompatible substances. Similarly, Eze and Ugwu (2022) reported that the majority of Biology laboratories in Enugu State secondary schools lacked proper ventilation systems, exposing students and teachers to potentially harmful fumes from preserved specimens and chemical reagents. The authors emphasized that laboratory benches were often constructed from materials unsuitable for chemical resistance, increasing the risk of surface contamination and accidents. These findings align with the observations of Ibrahim and Yusuf (2020), who noted that laboratory design deficiencies are

frequently overlooked during school construction and renovation, as safety considerations are often subordinated to cost-saving measures. The cumulative effect of these design inadequacies is a laboratory environment that predisposes both students and instructors to avoidable hazards depending on availability of safety equipment and materials in Biology laboratories.

However, beyond architectural design, the availability of safety equipment and materials is critical to the implementation of laboratory safety practices. Essential safety items include fire extinguishers, first aid kits, eyewash bottles, laboratory coats, safety goggles, gloves, and spill containment kits (Okafor & Nwagbo, 2021). Chukwu and Okoro (2023) conducted a comprehensive survey of forty senior secondary schools in Abia State and found that only 28% had functional fire extinguishers in their Biology laboratories, while a mere 22% had adequately stocked first aid kits. The study further revealed that basic personal protective equipment such as safety goggles and laboratory coats were unavailable in over 60% of the schools surveyed. Mohammed and Bello (2022) reported similar findings in their assessment of Biology laboratories in Kaduna State, where they observed that 71% of schools lacked spill containment materials, and 65% did not have proper waste disposal facilities for biological and chemical waste. The researchers noted that even when safety equipment was present, it was often expired, damaged, or improperly maintained, rendering it ineffective during emergencies. Ogunleye and Adeleke (2024) reinforced these observations, documenting that the absence of safety materials in Biology laboratories correlates strongly with the frequency of laboratory accidents. Their study across twelve states in southwest Nigeria found that schools with comprehensive safety equipment recorded 78% fewer laboratory incidents compared to those with minimal or absent safety provisions. These findings collectively underscore a systemic deficiency in the resourcing of Biology laboratories for safety.

Furthermore the presence of qualified laboratory assistants is another crucial factor in the implementation of safety practices. Laboratory assistants are responsible for preparing materials, maintaining equipment, ensuring proper waste disposal, and supervising students during practical sessions (Nwachukwu & Ezeh, 2021). However, Okon and Udofia (2022) reported that the majority of senior secondary schools in Akwa Ibom State operated their Biology laboratories without the services of trained laboratory assistants. In schools where laboratory assistants were employed, the assistants often lacked formal training in laboratory safety protocols, having been assigned to laboratory duties based on seniority rather than qualification. Akinwumi and Fashina (2023) investigated the role of laboratory assistants in safety implementation across Lagos State secondary schools and found that only 18% of schools employed certified laboratory technicians. The study further revealed that in schools without laboratory assistants, Biology teachers were solely responsible for laboratory preparation and supervision, leading to increased workloads and diminished attention to safety oversight. Adepoju and Ojo (2024) observed that the absence of laboratory assistants contributes significantly to poor safety practices, as teachers who are already stretched by heavy teaching loads are unable to dedicate sufficient time to the meticulous preparation and monitoring that laboratory safety demands. The researchers recommended the mandatory staffing of all secondary school Biology laboratories with trained laboratory assistants because the help among others in providing safety rules in Biology lab settings.

Safety rules constitute the operational framework that translates laboratory design, equipment, and personnel into a culture of safety. These rules encompass guidelines for proper conduct, handling of chemicals and biological specimens, use of protective equipment, waste disposal protocols, and emergency procedures (Nwosu & Obi, 2021). Despite the existence of prescribed safety regulations

from educational authorities, the extent of their implementation in senior secondary school Biology laboratories remains a significant concern.

Adebayo and Fadipe (2023) conducted a study across twenty-five senior secondary schools in Osun State and found that while 82% of schools displayed safety rules on laboratory walls, only 31% of students could recall or demonstrate knowledge of these rules when questioned. This gap between display and comprehension suggests that safety rules are often treated as decorative rather than instructional. The researchers further observed that regular safety drills were conducted in merely 12% of the schools surveyed, and only 9% maintained incident report logs documenting laboratory accidents.

Onyekwere and Chibuzor (2022) reported similar findings in their assessment of Biology laboratory safety implementation in Imo State. Their study revealed that compliance with basic safety rules such as wearing laboratory coats, tying back hair, and prohibiting eating or drinking in the laboratory was observed in fewer than 40% of the practical sessions monitored. The authors noted that teachers themselves sometimes modeled unsafe behaviors, inadvertently reinforcing students' disregard for safety protocols.

Ezeani and Okonkwo (2024) investigated the factors influencing the implementation of safety rules in Biology laboratories across Anambra State secondary schools. The study identified inadequate teacher training in laboratory safety, large class sizes, insufficient time allocated for practical sessions, and a lack of administrative enforcement as primary barriers to rule implementation. The researchers found that schools with regular safety audits and supervisory visits from education authorities demonstrated significantly higher compliance rates compared to those without such oversight.

Abubakar and Musa (2023) drew attention to the specific challenge of chemical and biological waste disposal. Their study in Bauchi State revealed that 76% of Biology laboratories disposed of used chemicals, culture media, and specimen remains through general waste bins rather than designated biohazard disposal systems, exposing students, staff, and the broader school community to potential health risks. This finding echoes earlier observations by Adekunle and Oyewole (2021), who documented similar disposal practices in 68% of schools studied in Ogun State and attributed them to the absence of clear enforcement mechanisms for existing waste management regulations.

The cumulative evidence from these studies suggests that while safety rules are established on paper across most school systems, their actual implementation in Biology laboratories remains severely limited. This implementation gap between policy intention and classroom reality constitutes the central problem that this study seeks to investigate. Thus, the study investigated he extent of implementation and adherence to safety practices among staff and senior secondary school student in Biology laboratories in Enugu South Local Government Area.

Statement of the Problem

Biology laboratory safety is foundational to effective science education, yet mounting evidence reveals a persistent implementation gap in Nigerian senior secondary schools. Studies have documented widespread deficiencies across four critical domains: inadequate laboratory designs and fittings that fail to meet minimum safety standards, acute shortages of essential safety equipment including fire extinguishers and protective gear, scarcity of trained laboratory assistants to supervise practical sessions, and poor compliance with safety rules despite their display on laboratory walls. Despite these documented challenges, no known study has systematically investigated the extent of

implementation of safety practices across all four dimensions specifically in Biology laboratories within Enugu South Local Government Area. This study therefore sought to fill this gap by examining the extent of implementation of safety practices in Biology laboratories among senior secondary school students in Enugu South Local Government Area.

Purpose of the Study

The purpose of this study is to identify the extent of implementation and adherence to safety practices among staff and senior secondary school student in Biology laboratories in Enugu South Local Government Area. Specifically, the study determined the:

1. General designs and fittings of Biology laboratories relevant to safety.
2. Availability of safety equipment and materials in Biology laboratories
3. Services of laboratory assistants that are employed to ensure safety.
4. Extent of implementation of safety rules Biology laboratory.

Research Questions

The following research questions have been formulated to guide the study.

1. What designs and fittings in the Biology laboratory are appropriate to ensure safety?
2. To what extent are safety equipment available in the Biology laboratory?
3. How often services of laboratory assistants employed do, ensures safety during laboratory practical?
4. To which extent does the secondary school Biology student apply safety practices during practical sessions?

Method

This study adopted a descriptive survey research design to investigate the extent of implementation of safety practices in Biology laboratories among senior secondary school students. The area of the study was Enugu South Local Government Area of Enugu State, located in the southeastern geopolitical zone of Nigeria. The population of the study comprised 256,480 senior Secondary School students offering Biology and 11,117 Biology teachers' public secondary schools in Enugu South Local Government Area.

The sample size for the study consisted of 100 respondents. A multi-stage sampling technique was employed to draw the sample. In the first stage, purposive sampling technique was used to select all the 20 public secondary schools in Enugu South Local Government Area where Biology is taught to get 25 Biology teachers.

At the students' side, a stratified random sampling technique was used to ensure that all the sampled schools were represented. Each school served as a stratum, and students were randomly selected. Proportional allocation was applied to ensure that the number of students selected from each school reflected their population sizes.

Instrument

The instrument used for data collection was a structured questionnaire developed by the researchers titled Extent of Implementation of Safety Practices in Biology Laboratory Questionnaire (EISPBQ). The questionnaire consisted of 18 items of four sections general designs and fittings of Biology laboratories relevant to safety, availability of safety equipment and materials in Biology laboratories, services of laboratory assistants that are employed to ensure safety and extent of implementation of safety rules Biology laboratory. The questionnaire was designed using a four-point

Likert scale of Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD), assigned values of 4, 3, 2, and 1 respectively. This enabled respondents to indicate their level of agreement with each statement.

The instrument was validated by three experts: two from the Department of Science Education and one from the Department of Measurement and Evaluation, Faculty of Education, Nnamdi Azikiwe University, Awka. The reliability of the instrument was established using Cronbach's Alpha, which yielded a coefficient of 0.75 after a pilot test conducted in a different local government area outside the study area.

Method of Data Analysis

Data collected from the study were analyzed using mean scores to answer the research questions. A criterion mean of 2.50 was used as the cut-off point. Any item with a mean score of 2.50 and above was regarded as agreed, indicating a high extent of implementation of the stated safety practice, while any item with a mean score below 2.50 was regarded as rejected, indicating a low extent of implementation. All mean scores were approximated to one decimal place.

Results

Research Question one: What designs and fittings in the Biology laboratory are appropriate to ensure safety?

Table 1: Mean responses on the designs and fittings in the Biology laboratories to ensure safety.

S/N	Item Description	N	SA	A	D	SD	Total	X Mean	Dec
1	The Biology laboratory is separated a little distance away from other buildings in the school compound	100	5 20	12 36	50 100	33 33	100 189	1.89	R
2	The Biology laboratory size is large and it accommodates learners for practical work		50 200	30 90	10 20	10 10	100 320	3.2	A
3	The Biology is equipped with different types of furniture such as tables, stools, cupboards, racks, shelves and chairs.		10 40	20 60	50 100	20 20	100 220	2.2	R
4	The Biology Laboratory is designed with large double doors at opposite ends		50 200	40 120	5 20	5 5	100 345	3.4	A
5	There are low and large windows facing one another as well as high windows.		40 160	60 120	0 0	0 0	100 280	2.8	A
	Total mean							2.70	

Table 1 shows the respondents responses (teachers' response) on the type of designs and fittings in the Biology laboratory appropriate to ensure safety. It shows the mean scores of 1.89, 3.2, 2.2, 3.4 and 2.8 therefore total mean for table 1 is 2.70 which is above the acceptable mean this means that the type of design and fitting in the Biology laboratory do not ensure safety.

Research Question two: To what extent are safety equipment available in the Biology laboratory?

Table 2: Mean responses on the availability of safety equipment in Biology laboratory

S/N	Item Description	N	SA	A	D	SD	Total	X Mean	Dec
6	There are first aid kits in the		30 120	10 30	50 100	10 10	100 260	2.6	A

	Biology laboratory							
7	The safety rules and slogan are hung on the wall.	40 160	10 30	43 86	7 7	100 283	2.8	A
8	The student wash their hands after Practical	50 200	30 90	10 20	10 10	200 320	3.2	A
9	Trash bins are present in the Biology laboratory for all types refuse	10 40	3 9	70 140	17 17	100 206	2.0	R
10	Hand gloves and goggles are available in the Biology laboratory	23 92	15 45	50 100	12 12	100 249	2.49	R
11	Bucket of dry sand are available in the Biology laboratory	50 200	32 96	7 14	11 11	100 321	3.21	A
12	Fire extinguishers are available in the Biology laboratory	50 200	20 60	20 40	10 10	100 310	3.1	A
	Total mean						2.7	

Table 2 shows respondent responses on the availability of safety equipment in Biology laboratory. It shows the mean scores of 2.6, 2.8, 3.2, 2.0, 2.49, 3.21 and 3.1. Therefore the total mean for table 2 is 2.7 which is above the acceptable mean, this means that there is availability of safety equipment in Biology laboratory.

Research Question three: How often do services of laboratory assistants employed, ensures safety during laboratory practical?

Table 3: Mean responses on the services of laboratory assistants and personnel ensuring safety in Biology laboratory.

S/N	Item Description	N	SA	A	D	SD	*M*	X	Dec
13	The laboratory assistants supervise the learners during practical activities in the Biology laboratory	200	80 230	14 42	6 12	0 0	100 284	2.8	A
14	The laboratory assistant gives out detailed instructions to the student before and during practical work		80 320	10 30	5 10	5 5	100 365	3.65	A
15	Labelled reagents are used during practical		11 44	9 27	50 100	30 30	100 201	2.01	R
	Total mean							2.8	

Table 3 shows respondent responses (students' responses) on the services of laboratory assistant and personnel ensuring safety in Biology laboratory. It shows the mean scores of 2.8, 3.65 and 2.01, therefore the total mean for table 3 is 2.8 which is above the acceptable mean this means that the services of laboratory assistants and personnel ensures safety in Biology laboratory.

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Research Question four: To which extent does the secondary school Biology student apply safety practices during practical sessions?

Table 4: Mean responses on the extent to which the following safety practices is applied during practical section in Biology laboratory.

S/N	Item Description	N	SA	A	D	SD	*M*	X	Dec
16	The students adhere strictly to the instructions given to them before and during practical work	100	5 5	15 45	50 100	30 30	100 180	1.8	R
17	The students wear their laboratory coat before entering the laboratory.		23 92	10 30	30 60	37 37	100 219	2.19	R
18	The students wear flat shoes to the Laboratory		40 160	20 60	10 20	30 30	100 270	2.7	A
	Total mean							2.23	

Table 4 shows respondent responses (teachers' responses) on the extent to which the following safety practices is applied during practical section in the Biology laboratory. It shoes the mean scores of 1.8, 2.19 and 2.7. Therefore the total mean for table 4 is 2.23 which is below the acceptable mean, this means that safety practices is not applied by the student during practical section in Biology laboratory.

Discussion of Results

The results in Table 1 present respondents' perceptions of the general designs and fittings of biology laboratories relevant to safety, yielding a total mean of 2.70 above the acceptable benchmark indicating that existing designs and fittings do not adequately ensure safety. Item 1, which assessed whether the biology laboratory is separated from other school buildings, recorded the lowest mean of 1.89, suggesting rejected adequacy. This finding sharply contrasts with Olatunde and Adebayo's (2021) assertion that laboratory isolation is foundational to safety, as proximity increases contamination and accident exposure risks. Conversely, Item 2 (laboratory size accommodating learners) and Item 4 (large double doors at opposite ends) scored above the acceptable mean (3.2 and 3.4 respectively), suggesting partial compliance with design standards for space and emergency egress. However, Item 3, concerning the availability of diverse furniture, recorded a low mean of 2.2, aligning with Eze and Ugwu's (2022) observation that benches are often constructed from unsuitable materials. Item 5 (low and high windows) scored 2.8, indicating moderate acceptance yet falling short of the ventilation adequacy emphasized by Adeyemi and Olarewaju (2023). The overall mean of 2.70 confirms that despite isolated compliant features, the cumulative design deficiencies as earlier reported by Ibrahim and Yusuf (2020) regarding cost-saving compromises produce a laboratory environment that predisposes users to avoidable hazards, ultimately undermining safety implementation in biology practical sessions.

Table 2 presents respondents' perceptions on the availability of safety equipment and materials in biology laboratories, with a total mean of 2.7 above the acceptable benchmark indicating inadequate provision. Items 6 (first aid kits, mean 2.6) and 7 (safety rules on walls, mean 2.8) suggest moderate presence, yet these figures fall short of Chukwu and Okoro's (2023) recommended standard, who found that only 22% of schools had adequately stocked first aid kits. Item 9 (trash bins, mean 2.0) and Item 10 (hand gloves and goggles, mean 2.49) were rejected, confirming Mohammed and Bello's (2022) observation that 71% of schools lacked basic protective equipment and spill containment materials. These deficiencies are particularly concerning given Ogunleye and Adeleke's

(2024) finding that schools with comprehensive safety equipment recorded 78% fewer accidents. While Items 8 (hand washing, mean 3.2), 11 (dry sand bucket, mean 3.21), and 12 (fire extinguishers, mean 3.1) were accepted, their presence alone cannot compensate for the systemic absence of other critical items, as Okafor and Nwagbo (2021) emphasized that safety equipment must be collectively available to ensure comprehensive laboratory safety. The overall mean of 2.7 confirms a systemic deficiency in resourcing biology laboratories for safety.

Table 3 presents respondents' perceptions of laboratory assistants' services, with a total mean of 2.8 above the acceptable benchmark indicating that their services do not adequately ensure safety. Item 13 (assistants supervise learners, mean 2.8) was accepted, yet this contradicts Okon and Udofia's (2022) finding that most schools operated without trained assistants. Item 14 (assistants give detailed instructions, mean 3.65) was highly accepted, suggesting some level of instructional support. However, Item 15 (labelled reagents used, mean 2.01) was rejected, revealing a critical safety gap. This aligns with Akinwumi and Fashina's (2023) report that only 18% of schools employed certified technicians, while 82% relied on untrained personnel. Adepoju and Ojo (2024) emphasized that without qualified assistants, teachers' heavy workloads compromise safety oversight. The overall mean of 2.8 confirms that despite some supervisory presence, the quality of laboratory assistance remains insufficient, consistent with Okeke and Nzewi's (2022) observation that concerns persist regarding personnel adequacy in Nigerian secondary school biology laboratories.

Table 4 presents respondents' perceptions on the extent of safety rule implementation, with a total mean of 2.23 below the acceptable benchmark indicating poor implementation. Item 16 (students adhere to instructions, mean 1.8) was strongly rejected, aligning with Adebayo and Fadipe's (2023) finding that only 31% of students could recall safety rules despite 82% display rates. Item 17 (wearing laboratory coats, mean 2.19) was also rejected, consistent with Onyekwere and Chibuzor's (2022) observation that compliance with basic safety rules occurred in fewer than 40% of practical sessions. Only Item 18 (wearing flat shoes, mean 2.7) was marginally accepted. The overall mean of 2.23 confirms Ezeani and Okonkwo's (2024) identification of inadequate training and lack of enforcement as primary barriers to implementation, as well as Abubakar and Musa's (2023) and Adekunle and Oyewole's (2021) concerns regarding absent enforcement mechanisms, revealing a critical gap between prescribed regulations and actual safety practices.

Conclusion

The study concludes that the implementation of safety practices in biology laboratories in Enugu South Local Government Area is generally inadequate. Although some elements of laboratory design, safety equipment availability, and laboratory assistance showed moderate compliance, significant deficiencies persist. Poor laboratory isolation, inadequate safety materials, unqualified personnel, and weak enforcement of safety rules collectively undermine safety standards. The low level of students' adherence to safety practices further exacerbates risks, indicating an urgent need for improved facilities, adequate resources, trained personnel, and stricter enforcement of safety regulations.

Recommendations

1. School administrators and government education authorities should upgrade laboratory infrastructure by improving isolation standards, providing adequate safety materials, and ensuring proper design to meet required safety benchmarks.

2. Education boards and school management should recruit and train qualified laboratory personnel while strengthening supervision to ensure consistent enforcement of safety rules and proper management of laboratory activities.
3. Teachers and laboratory staff should promote students' adherence to safety practices through regular orientation, monitoring, and strict enforcement of regulations to reduce risks and improve overall laboratory safety compliance.

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