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Secondary School Students' Perception of Science Laboratory Accident Status and Preventive Measures in Awka Education Zone

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ABSTRACT

Purpose of the study: The study investigated secondary school students' assessment of science laboratory accident status and preventive measures in the Awka Education Zone. Two research questions guided the study, and one hypothesis was tested at a .05 significance level.

Methodology: The study used the descriptive survey research design. A sample of 156 public and 40 private secondary school students was used. A checklist and a questionnaire were used to collect data. The questionnaire was validated, and a Cronbach Alpha reliability test gave a coefficient of 0.86. The collected data was used to analyze mean, standard deviation, percentage, and t-tests.

Main Findings: The results revealed that science laboratory accidents do not occur in secondary schools in Awka Education Zone, irrespective of school type. The study also observed no significant difference in the preventive measures against science laboratory accidents adopted by private and public secondary school students in the zone.

Novelty/Originality of this study: There is limited literature in the present study's area seeking to assess the laboratory accident status in secondary schools and the measures the students take to avert these accidents. Thus, the present study's findings would provide background information on laboratory activities and accidents in the area of the research and preventive measures to be deployed.

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1. INTRODUCTION

The study of science cannot be complete without the laboratory. The science laboratory provides the necessary learning environment for concretising abstract science concepts and making the teaching and learning of science in schools easier. In as much as the science laboratory enhances the teaching and the learning of science through laboratory experiments, certain health and safety concerns have been raised as teachers and students make use of the school laboratories for conducting science experiments in a bid to maximise the benefits of the laboratory while controlling for laboratory accidents.

Science is seen as a systematic means of acquiring knowledge and understanding natural phenomena. Science is the study of nature and natural phenomena Nwele and Klaavuniemi and Siponen which requires several systematic procedures and skills for engagement [1], [2]. As a systematic means of acquiring knowledge and carrying out scientific exercises, science uses observation and experimentation to describe and explain natural phenomena [3]. The assertion above implies that science is never gullible but systematic in its approach. Therefore, observation and experimentation give uniqueness to the subject and practice of science. Al-Dahhan and Hieronymi emphasized the above statement when they said that scientific experimentation plays an important role in the progress of science as a large number of inventions and path-breaking discoveries have been made possible through investigations that are usually carried out in laboratories [4], [5]. According to Mbajiorgu and Igwe, as cited in [1], the act of scientific investigation may involve outdoor activities or formal experiments in a school science laboratory. Outdoor activities include visitation to look out for flowers, rocks, rivers, and the sky in their natural settings. Other things that can be observed during outdoor activities are trees, animals, birds, and landscapes. Most of the time, these materials that are observed during outdoor activities are taken into the science laboratory to examine their structural and chemical compositions. These examinations in the science laboratories constitute formal experiments in school science laboratories. Thus, whether outdoors or in a formal experiment, scientific investigations are inseparable from the science laboratory.

A science laboratory is a formal setting for scientific investigations and experiments. It is a place where basic experimental skills are learned by performing a set of prescribed experiments [4]. Science laboratory blocks are usually separate from other classrooms in most secondary school settings. This is why [6] stated that the science laboratory is a special room where students can practice science. The purpose and process involved in practising science in the laboratory give the laboratory its unique identity.

In practising science in the laboratory, students, under the supervision and guidance of the teacher, may handle, examine, draw objects, or perform experiments to find more information about the object under investigation. In the course of doing the aforementioned, students can develop some basic science skills [4], [7] of observation, classification, communication, measurement, inference, and prediction. These corresponding science skills acquired from science practice make the science laboratory essential in the teaching and learning of science, especially in secondary schools. The above statement is corroborated by Fagihi assertion that the laboratory is the heart of science education [8]. The researcher further posited that the school laboratory is the most important learning environment in the school used for teaching science. In other words, laboratory exercises distinguish the laboratory as an important learning environment for teaching science compared with other fields of knowledge. This is because laboratory exercises involve learning and doing. Also, the importance of the school science laboratory is highlighted in [9], wherein the researchers posited that science could not be taught effectively within the four walls of the classroom of knowledge abstraction but in the laboratory of concrete experiences. Therefore, combining classroom learning with laboratory experiences in science education can make all the sense organs come alive, enabling the students to form a deep understanding of the science concept taught by the teacher.

Science education is very important to the development of any nation. Nwune defined science education as the exposition of learners to science content and processes both in formal and informal settings [10]. Science education comprises primarily three subjects, namely biology, chemistry and physics, taught at senior secondary schools in Nigeria [11]. Every senior secondary school is expected to have a well-furnished and functioning laboratory. Predominantly, only a few secondary schools have separate laboratories for these three science subjects. On the other hand, most secondary schools use the same laboratory for the three subjects. Based on the roles of the science laboratory in science teaching and learning, it implies that secondary schools without laboratories where students can carry out practical exercises would end up producing graduates who would have no knowledge and skills of practical science required by the West African Examination Council (WAEC) and the National Examination Council (NECO) to pass the senior school certificate examination (SSCE) [12]. Omiko further stressed that such students would lack the requisite qualifications for courses like medicine, engineering, agricultural science, and any science-related disciplines [12]. Nevertheless, the use of the school science laboratories has major concerns and risk factors; accidents and hazards.

Science laboratories are potentially dangerous working environments, often characterised by a wide variety of toxic, flammable, corrosive, or reactive chemical compounds. Laboratory accidents are unplanned and unintentional damage to individuals and facilities in the laboratory [6] which students and teachers can be victims of. Nwele., Idoko and Ibiam., Shrivastava, observed that laboratories are prone to hazards due to the presence of dangerous chemicals and equipment not carefully handled by the users [1], [13], [14]. Schools should therefore be on the alert at all times and take/set up active measures to minimise and manage the occurrence of science laboratory accidents effectively.

Cla and Clo identified some possible accidents that could occur in the science laboratory, including cuts, heat/burns/scalds, fire outbreaks, eye accidents, inhalation of poisonous gases, and animal bites [15], [16]. Aliyu attributed laboratory accidents to teachers' factors, such as teachers working outside their subject discipline, poor laboratory design, and their breach of precautionary measures [17]. Also, Ikeobi and Aydogdu corroborate the assertion that laboratory accidents are teacher-related since the teacher is responsible for organising and managing the interaction between learners and the learning materials [18], [19]. On the other hand, science laboratory accidents were student-related [15], [18] and [20]. The researchers observed a generally low awareness of laboratory safety skills among secondary school students in Nigerian schools and, more particularly, among rural secondary school students. The assertion by these researchers that science laboratory accidents are student-related was also sustained by international researchers [21]-[23].

Research identified the main causes of student-related science laboratory accidents to include non-availability and utilisation of laboratory protective equipment, unwanted student behaviours, carelessness and crowded classrooms [1], [15], [18], [20], [24]. These student-related factors are more predominant in public than private secondary schools [25]. Thus, the present study seeks to determine if school type (public and private) plays any role in science laboratory accident status. Also, the study seeks to determine the science laboratory accident preventive measures deployed by public and private secondary school students in averting accidents in science laboratories. What is the science laboratory accident status in public and private secondary schools in Awka Education Zone? And What are the preventive measures taken by public and private secondary school students to avert the occurrence of science laboratory accidents in Awka Education Zone?

2. RESEARCH METHOD

The research paradigm used in this study is the post-positivism paradigm. This paradigm is an offshoot of the positivism paradigm and they both share similar ontological (realism) and epistemological (objectivism) positions [22]. Irrespective of the similar positions they share, these two paradigms differ in their assumptions about reality. For example, unlike the positivism paradigm, the post-positivism paradigm assumes that realities are not absolute but subjective to the construction of meanings by different participants [23]. Thus, for post-positivists, data about any subject matter should only be collected from participants with first-hand experience. This paradigm's methodology uses research designs/procedures such as surveys and instruments such as closed-ended questionnaires to generate quantitative data [24] and [26] while descriptive and inferential statistics are used for analysing these data to identify the cause and effect or relationships between variables of interest. Therefore, this present study adopts the descriptive survey research design/procedure that describes and presents basic information about the subject matter under study [25].

The population of the study comprised 780 and 320 public and private senior secondary school two (SSS 2) science students in Awka Education Zone, respectively. The sample of the study comprised 156 and 40 SSS 2 students in public and private secondary schools in Awka Education Zone, respectively. The sample was selected through a multistage sampling procedure. The stages were as follows: The first stage was to put the five Local Government Areas that make up Awka Education Zone into five strata. Then, three Local Government Areas were selected using a simple random sampling technique. The second stage involved using a simple random sampling technique to select one public and one private senior secondary school from each of the selected local government areas. Finally, the third stage involved using simple random sampling again to select one arm of the SSS 2 classes in each of the selected schools. The choice of SSS 2 students was based on the fact that they have been involved in laboratory procedures for two years and they are not newbies and examination classes like their SSS 1 and 3 counterparts, respectively.

Two instruments were used to collect data for the study. The first was titled the Common Science Laboratory Accidents Checklist (CSLA), adapted from [15]. The instrument was used to check the status of science laboratory accidents in the selected public and private secondary schools in Awka Education Zone from the perspective of the students. The instrument was validated by relevant experts from Nnamdi Azikiwe University Awka. The checklist is a two-point rating of yes and no with weights of 1 and 0, respectively. The second instrument used to collect data for the study is the Laboratory Accident Preventive Measure Questionnaire (LAPMQ), adapted from [27]. The instrument was also validated by relevant experts, and a reliability test conducted on the instrument gave a reliability coefficient of 0.86 using Cronbach Alpha. The questionnaire is a four-point rating scale of strongly agree (SA), agree (A), disagree (D), and strongly disagree (SD) with weights of 4, 3, 2, 1 for positive statements and 1, 2, 3, 4 for negative statements. The questionnaire was used to determine the preventive measures adopted by secondary school students in averting science laboratory accidents in the selected secondary schools in Awka Education Zone.

The researchers administered the instruments with the help of three trained research assistants. The research assistants were exposed to the objectives of the study and briefed on how to collect data using the instruments. The instruments were administered and collected on the same day. In analysing the collected data, the researchers used descriptive statistical tools (mean, standard deviation, and percentages) to answer the research questions and inferential statistics (t-test). For example, in answering research question one, the midpoint percentage (50%) was used to determine the science laboratory accident status in the selected secondary schools in Awka Education Zone. A mean average of 2.50 was used to determine the science laboratory accident preventive measures adopted by secondary school students in Awka Education Zone. For the hypothesis, in taking a decision where the P-value is less than or equal to a significant value of .05 ($P<.05$), the null hypothesis was rejected, but if otherwise ($P>.05$), the null hypothesis was accepted.

3. RESULTS AND DISCUSSION

In this section, the collected data were analysed, interpreted, and the findings were discussed. The results and discussion were presented based on the research questions and hypothesis that guided the study.

Table 1. Percentage distribution of science laboratory accident status in public and private secondary schools in Awka Education Zone

ITEM	PUBLIC YES (%)	PUBLIC NO (%)	PUBLIC STATUS	PRIVATE YES (%)	PRIVATE NO (%)	PRIVATE STATUS
Cuts; as a result of broken test/glass tubes	17.9	82.1	NO	20	80	NO
Cuts; as a result of broken tools	14.7	85.3	NO	25	75	NO
Cuts; as a result of sharp-edge injuries	19.9	80.1	NO	25	75	NO
Heat/Burn/Scalds as a result of carelessness in handling hot objects	19.2	80.8	NO	20	80	NO
Heat/Burn/Scalds as a result of hot liquid accidents	13.5	86.5	NO	15	85	NO
Heat/Burn/Scalds as a result of Bunsen flame	10.9	89.1	NO	10	90	NO
Heat/Burn/Scalds as a result of a lighted match	18.6	81.4	NO	32.5	67.5	NO
Heat/Burn/Scalds as a result of acid/strong base	17.9	82.1	NO	25	75	NO
Fire Outbreak as a result of accidental ignition of flammable liquids	17.9	82.1	NO	15	85	NO
Fire Outbreak as a result of ignition as a result of defective burner tube leakage	10.9	89.1	NO	20	80	NO
Eye Accidents as a result of Chemical splash onto the eyes/skin	17.9	82.1	NO	20	80	NO
Eye Accidents as a result of Rubbing of the eyes with hands contaminated with chemicals	21.2	78.8	NO	30	70	NO
Animal bite in the laboratory	7.1	92.9	NO	20	80	NO
Explosion	10.9	89.1	NO	17.5	82.5	NO
Electric shock	23.7	76.3	NO	27.5	72.5	NO
Slips and falls	35.9	64.1	NO	40	60	NO

The result in Table 1 shows that science laboratory accidents do not occur in secondary schools in Awka Education Zone as determined using the midpoint percentage of 50%. The result showed 'NO' responses from the students to science laboratory accidents as a result of cut from broken glass/test tubes (82.1%), broken tools (85.3%), and sharp edges (80.1%); as a result of heat/burn/scalds from carelessness from handling hot objects (80.0%), hot liquid accident (86.5), Bunsen flame (89.1%), lighted match (81.4%) and acid/strong base (82.1%); as a result of fire outbreak from accidental ignition of flammable liquids (82.1%), defective bunsen burner tube leakage (89.1%); eye accident as a result of chemical splash (82.1%), rubbing the eyes with contaminated hands (78.8%). The result also showed students 'NO' responses to other forms of science laboratory accidents such as animal bites (92.9%), explosions (89.1%), electric shock (76.3%) and slips and falls (64.1%). This contradicts the findings of [15], who posited that these science laboratory accidents occur in schools and were a result of student-related factors.

The non-occurrence of science laboratory accidents in the sampled secondary schools could be attributed to their teachers' communication and the students' adherence and compliance with science laboratory accident preventive measures. Also, this could be a result of teachers' and students' competence and efficiency in carrying out science laboratory procedures. Similarly, the presence of science laboratory safety equipment could have contributed to the non-occurrence of these science laboratory accidents, as reported by the students.

Table 2. Mean and standard deviation distribution of science laboratory accidents preventive measures of public and private secondary school students in Awka Education Zone

ITEM	Public		Private	
	$\underline{X}$±SD	Remark	$\underline{X}$ + SD	Remark
I always take care that the laboratory is clean and tidy	3.32±.76	AGREE	3.02±.91	AGREE
I know precautions to be taken in case of a fire in the laboratory	3.02±.92	AGREE	2.92±.85	AGREE
I know what to do in case of spills and splashes of chemicals	2.71±.91	AGREE	2.77±.91	AGREE
I am aware of the right emergency kits to use in case of an emergency	2.72±.98	AGREE	2.65±.92	AGREE
I know the phone numbers to call in an emergency	2.94±1.01	AGREE	2.72±1.10	AGREE
I have information about my health status	3.16±.90	AGREE	3.12±.88	AGREE
I know what should be the standards of an ideal laboratory for schools	2.83±.93	AGREE	2.90±.98	AGREE
I can use the ventilation system very well	2.74±.98	AGREE	3.12±.99	AGREE
I can manipulate the electrical and lighting in the laboratory	2.33±.99	DISAGREE	2.42±1.08	DISAGREE
I know how to use the water system in the laboratory	3.02±.94	AGREE	3.22±.76	AGREE
I know how to use gas installations	2.34±1.02	DISAGREE	2.40±1.03	DISAGREE
In case of a fire, I know how to use the fire extinguisher	2.85±1.06	AGREE	2.97±1.04	AGREE
I know how to use a bucket of sand in case of a fire	3.14±.96	AGREE	3.00±1.01	AGREE
I know how to use a fire blanket in case of a fire	2.56±1.02	AGREE	2.67±1.16	AGREE
I know how to design laboratory desks for laboratory exercises	2.69±.98	AGREE	2.87±.85	AGREE
I know the needs and uses of an emergency exit plan	2.75±.99	AGREE	2.75±.92	AGREE
I know how to use first aid kits in the laboratory	2.87±1.00	AGREE	3.17±.78	AGREE
I know how to store and keep solid chemicals	2.56±.99	AGREE	2.87±.93	AGREE
I always take care that the shelves are firmly attached to the wall	2.64±.97	AGREE	2.67±.85	AGREE
I always take care that all shelves have the protection sets on the front sides	2.59±.96	AGREE	2.72±.87	AGREE
I know how to store and keep the liquid chemicals	2.62±1.00	AGREE	2.82±.87	AGREE
I know how to store chemicals which need to have special conditions	2.44±.99	DISAGREE	2.62±.80	AGREE
I work with an inventory that has the identifications of all chemicals in the laboratory	2.26±1.03	DISAGREE	2.50±.81	AGREE
I make sure to wash my hands after each laboratory exercise	3.58±.69	AGREE	3.65±.62	AGREE
Conclusion		**AGREE**		**AGREE**

The result in Table 2 shows that public secondary school students disagreed with item numbers 9, 11, 22 and 23 but agreed with the rest of the other items. On the other hand, private secondary school students disagreed with items numbers 9 and 11 but agreed with the other items in the questionnaire. Overall, the student's responses indicate that they practice science laboratory accident preventive measures in their schools' science laboratories. This finding contradicts the findings who posited that students have low awareness and, as a result, do not observe these preventive measures in the science laboratory [20]-[23].

The finding of the study could be because of students' high consciousness of the potential danger and accidents that could occur in the laboratory and the high value the students place on their lives and safety. Similarly, the finding could be a result of students' sense of responsibility even in the science laboratory.

Table 3. T-test of significance on the preventive measures between public and private secondary schools.

	Sig.	t	df	p	$\underline{X}$ Difference	SE Difference	Decision
Preventive Measures	.228	-931	194	0.05	-1.81731	1.95200	Not Significant

The result in Table 3 shows that there is no significant difference in the science laboratory accident preventive measures observed by public and private secondary schools in Awka Education Zone. The null hypothesis was therefore accepted. The findings of the study disproved [25] assertion that public and private secondary schools differ on certain factors, such as classroom size. The findings of the study show that these supposed differing factors do not apply to the sampled public and private secondary schools and their students in the adherence and compliance to science laboratory accident preventive measures. Thus, the sampled secondary schools are alike in this respect.

The findings imply that teachers and students covered in the sample of this study, irrespective of their school types, possess and efficiently deploy laboratory safety measures while using the science laboratories to carry out laboratory procedures. This knowledge and application of laboratory safety measures translate to the non-occurrence of laboratory accidents as observed by the findings of the study. The relatively small sample size used in this study poses a limitation to the generalisability of the study's findings to a more general population.

4. CONCLUSION

Based on the findings of the study, the researchers concluded that the investigated public and private secondary schools in Awka Education Zone do not experience science laboratory accidents. The researchers also concluded from the study's findings that students in both public and private secondary schools observed some science laboratory accident preventive measures before, during and after each laboratory exercise. The study also observed that there was no significant difference in the observance of science laboratory accident preventive measures irrespective of the school type.

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