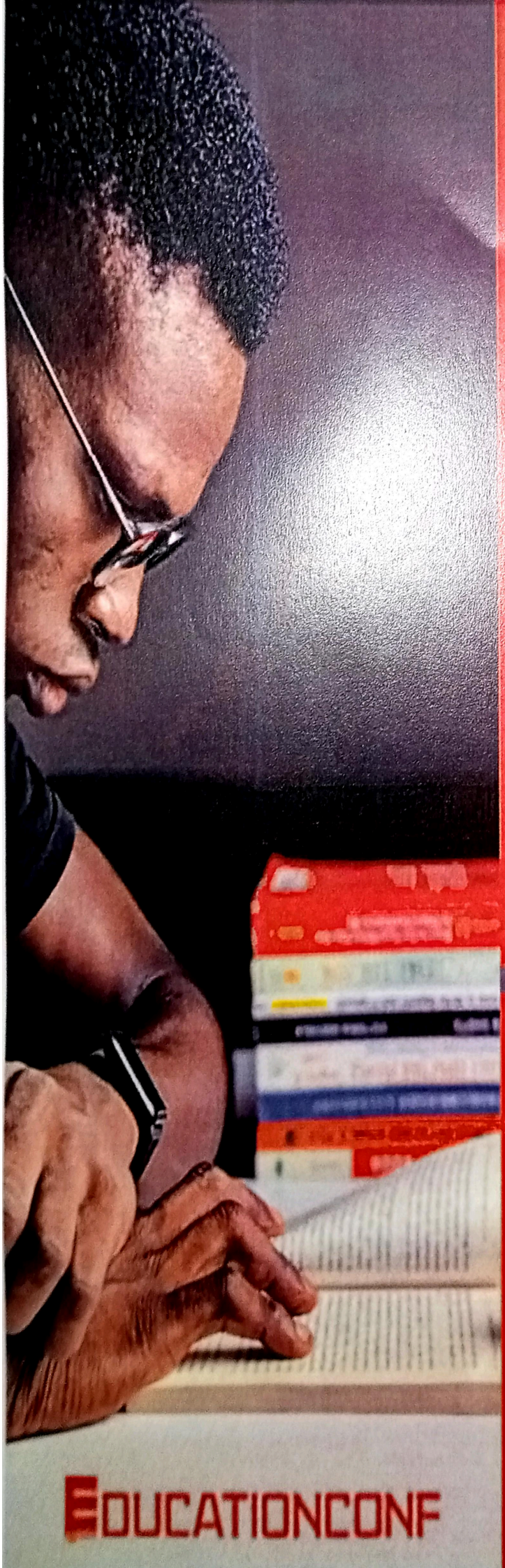

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Appraising Undergraduate Science Education Students Awareness of Laboratory Waste Disposal Management Techniques

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Abstract

The study was an appraisal of undergraduate students' awareness of laboratory waste disposal management techniques (LAWDMT) in the Federal University of Technology, Minna, Niger State, Nigeria. Descriptive survey research design was adopted in collecting respondents' awareness on laboratory waste disposal (LWD). The population of the study was 154 final years (500 Level) Science Education (SED) students who were completing their study in 2018/2019 academic session in the University. A Sample of 40 Biology and Chemistry education students randomly selected and given the questionnaire to complete and return same. The sample size consisted of 17 males (42.5%) and 23 females (57.5%) science education students. The instrument was titled 'Laboratory Waste Disposal Management Technique Awareness Questionnaire' (LAWDISMAQ) containing 20 items developed by the researcher and validated by Laboratory Technologist in Chemistry and Biology Laboratories of the University. It is 4-Point Likert type Scale. The reliability coefficient was determined using Cronbach alpha statistics and was found to be 0.84. LAWDISMAQ was distributed and collated by research assistants who also helped in coding the respondents' views. Descriptive statistics were used to analyze the data collected using Means (X) and Standard Deviations. Findings of the study shows that Science Education have awareness of Laboratory Waste Management Techniques with a Mean Score of 2.75. There was however no difference between male and female students on laboratory awareness techniques. It was recommended that Laboratory Technologist should continue to maintain Laboratory Safety Standards to continue to sustain and forestall accidents and equipment damage control measures in the laboratories.

Keywords: Appraisal, Undergraduate students, Awareness, Laboratory Waste, Disposal Management Technique

Background to the Study

Laboratory waste disposal awareness (LWD) is a critical factor if higher institutions of learning are to implement effective safety regulations practices. It is essential that a culture of safety is instilled in the science laboratory amongst students by adopting appropriate ethical rules and regulations. Laboratory malpractice may occur whenever a laboratory working staff or technician fails to oversee the safety, accuracy and precision of laboratory work (Ponferrada et al, 2017). Schools' Science Laboratories bye-products (waste) from experiments can be very toxic and hazardous to the health and environment of the students thus the knowledge of how such waste are disposed in compliance with standard safety regulatory standards becomes very apt. Liquid, gaseous and solid waste are unavoidable by-products of laboratory experiments in schools which if not appropriately managed can leads to environmental degradation and can pose health hazards or risk of getting injury amongst students. Health hazards that can be recorded in the science laboratory when there is accidents or contacts with following sources:

S/N	Substance or Energy Source	Potential Harm or Hazard
1.	Broken Glass	Cut
2.	Sodium Hydroxide	Blistering of Skin/Burns
3.	Bunsen Burner	Burns
4.	Wet Floor	Slipping off
5.	Gas Fumes	Choking of Breath/Lungs
6.	Liquid Toxic Drains	Pollutants/Contamination

Source: Adapted from Chemical Laboratory Safety (American Chemical Society).

Waste generation and disposal have over the past-decades become particularly problematic throughout the world (Starovoytova, 2018). He posited that the waste is completely unavoidable however the way it is handled, stored, collected and disposed-off will determine the quality of our surrounding environment to be either clean, pleasant, healthy and sustainable. Safe University environmental condition can contribute significantly to quality of learning and increase the productivity of students. However, indiscriminate disposal of waste by students not using the appropriate Waste Disposal Management Techniques (WDMT) poses a serious problem that could hinder the prospect of any nation philosophy of education (Bueno, 2019). A sustainable environment is a precursor for the attainment excellence of the future generation of scientist that will make our economy strive even in the face of global economy meltdown. Adoption of inappropriate waste disposal management techniques in schools constitutes major challenges to declining environmental health conditions (water and air pollution) and sustainable developments on all fronts.

Parts of the Science Education (SED) curricula of either Chemistry Education (CE) or Biology Education emphasizes acquisition of practical skills for the design and management of secondary school laboratory. In addition, students are expected to be equipped with the knowledge and skill or techniques of maintaining science laboratories. Waste Disposal Management (WDM) has 3 basic components namely collection, transportation and disposal. A comprehensive waste disposal management technique of a University could entail a wide

range of activities; collection, sorting (separation) of biodegradable from non-biodegradable, materials, modification, treatment, recycling (Licy, Vivek, Saritha, Anies & Josphina, 2013). So, there is the urgent need to streamline and determine whether undergraduate science education students who form the bedrock of quality science teaching at the basic and post-basic education levels their levels of awareness of science laboratory (SL) waste disposal management techniques (WDMT). Klarence et, al (2017) is of the view that literature is essential to build SWM awareness in academic institutions. So doing will improve practices towards solid waste disposal and adopting recycling options and awareness. Future science educationist must possess the knowledge of SL waste management so that he can play an effective role on environmental sustainability. Hence, this study was an attempt to determine whether Federal University of Technology, Minna undergraduate students possess the awareness of Laboratory waste disposal management techniques.

Statement of the Problem

Students Laboratory management culture have been on the decline. This can be evaluated from their disposition towards laboratory Management culture and in terms of their knowledge of laboratory waste disposal practices. Often you find laboratory reaction solution inappropriately disposed-off in and around the science laboratory not minding the health hazards those substances portend to their lives and the environment. This seemingly lack of culture and poor laboratory maintenance practices prompted this investigation to determine whether science education students' have awareness of laboratory waste disposal management techniques in the University.

Aim and Objectives of the Study

The study was designed to achieve the following specific objectives which are to:

1. Find out whether science education have the awareness on Laboratory Waste Disposal Mechanisms
2. Find out whether Male and Female students have the same awareness levels on Laboratory Waste Disposal Mechanisms
3. determine how often is laboratory waste generated disposed-off in the university
4. determine whether there are Laboratory Waste Disposal Incinerators in the University
5. find out whether students are aware that University Laboratories can generate Toxic Harmful substances

Research Questions

The following research questions were raised:

1. Do Science Education Students have the awareness of Laboratory Waste Disposal Mechanisms?
2. Do Male and Female students have the same awareness levels of Laboratory Waste

Disposal Mechanisms?

3. How often is the laboratory waste generated disposed?

4. Are there adequate Laboratory Waste Disposal Incinerators in the University?

5. Are you aware that University Laboratories can generate Toxic Harmful substances?

Research Methodology

Descriptive survey research design was adopted for the study in order to obtain data to describe the undergraduate students' awareness of Laboratory Waste Disposal Management mechanisms in the University. The population of the study was 154 (500 Level) final year Biology and Chemistry Education students of 2018/2019 academic session in the University. Out of the expected number of respondents (n = 154) only less than 27% (n = 40) of students completed and returned their questionnaires. Thus, the sample size of the study were 17 male students that constituted 42.5% and 23 female students who are majority (57.5%) of science education students. The instrument for data collection was a researcher designed survey questionnaire entitled Laboratory Waste Disposal Management Awareness Questionnaire (LAWDISMAQ) which contained only 20 items. The questionnaire had two sections; section 'A' elicited for students' demographic information while section 'B' contained statements on harmful/toxic nature of laboratory waste products to human health, ways of disposing-off the waste materials, how toxic pollutants affects soil ecology/environment which could influence climate change. LAWDISMAQ was validated by experts i.e. Laboratory Technologist and Science Education specialist in the University. A reliability coefficient of 0.84 was obtained using Cronbach alpha. Questionnaires were distributed research assistant (postgraduate student) who is undergoing a Masters' programme in the department. Data collected was subjected to descriptive statistics of Means (X), Standard Deviations (SD), frequency counts and percentages Microsoft Office (Excel) 2010 version.

Analysis of the Research Questions

1. Do Science Education Students have the awareness of Laboratory Waste Disposal Mechanisms?

Table 1: Analysis of LAWDISMAQ using Mean (X) and Standard Deviation (SD)

S/N	Statements	Mean X	Standard Deviation SD	Remarks
1	Laboratory waste products can be harmful to human health	2.70	0.56	HA
2	Laboratory waste product must be properly disposed off	2.60	0.63	HA
3	Chemical fumes or gases can cause cancer and incurable ailments	2.70	0.61	HA

4	Laboratory waste products can be harmful to soil micro-organisms	2.63	0.54	HA
5	Laboratory waste products can cause air pollution	2.75	0.54	HA
6	Hazardous waste from the laboratory can be harmful and causes contaminations	2.73	0.55	HA
7	Laboratory waste products also impact on animal and marine life	2.68	0.53	HA
8	Laboratory waste product can cause extreme climate change	2.58	0.64	HA
9	Laboratory harmful substances is gradually destroying the ecosystem	2.58	0.59	HA
10	Laboratory waste mechanisms education should be giving to students and lecturers	2.73	0.45	HA

***HA: Have Awareness**

Result of analysis on Table 1 shows the Means (X) and Standard Deviations (SD) of science education students awareness level of Laboratory Waste Disposal Management Techniques (LAWDIWATAI) in the University. The result shows that respondents are aware of that 'Laboratory waste products can be harmful to human health' with a X score of 2.70 and standard deviation of 0.56. There awareness of 'Chemical fumes or gases can cause cancer and incurable ailments' had X score of 2.70 and Standard deviation of 0.61. The item that 'Laboratory waste products can cause air pollution" had the highest X score of 2.75 and a deviation of 0.54. This meant that, Science Education Students in the University have high Laboratory Waste Disposal Management Techniques.

2. Do Male and Female students have the same awareness levels on Laboratory Waste Disposal Mechanisms?

Table 2: Analysis of LAWDISMAQ on the basis of Gender using Mean (X) and Standard Deviation (SD)

S/N	Statement	M X	M SD	F X	F SD	REMARKS
1	Laboratory waste products can be harmful to human health	2.73	0.45	2.64	0.75	HA
2	Laboratory waste product must be properly disposed off	2.56	0.64	2.64	0.63	HA
3	Chemical fumes or gases can cause cancer and incurable ailments	2.65	0.63	2.79	0.56	HA
4	Laboratory waste products can be harmful to soil micro-organisms	2.73	0.53	2.43	0.51	HA
5	Laboratory waste products can cause air pollution	2.77	0.51	2.71	0.61	HA
6	Hazardous waste from the laboratory can be harmful and causes contaminations	2.62	0.63	2.93	0.27	HA
7	Laboratory waste products also impact on animal and marine life	2.65	0.56	2.71	0.47	HA
8	Laboratory waste product can cause extreme climate change	2.62	0.57	2.50	0.76	HA

9	Laboratory harmful substances is gradually destroying the ecosystem	2.69	0.55	2.36	0.63	HA
10	Laboratory waste mechanisms education should be giving to students and lecturers	2.77	0.43	2.64	0.50	HA

***HA: Have Awareness**

Table 2 shows the result of male and female science education students responses on Laboratory Waste Disposal Management Techniques (LAWDIWATAI) in the University. 'Laboratory waste products can be harmful to human health' recorded a X=2.73, and SD=0.45 for Males while Females scored X=2.64 and SD=0.75. There awareness on 'Laboratory waste product can cause extreme climate change' scored the lowest X scores of 2.62 and SD 0.57 by Male students while Female students recorded a X of 2.50 and SD 0.76. On all the items, both male and female indicated that, the 'Have Awareness' of Laboratory Waste Disposal Management Techniques.

3. How often is the laboratory waste generated disposed?

Table 3: Frequency and Percentage distribution of Laboratory Waste Disposal Routine in the University

S/N	Duration	Frequencies (Freq)	Percentage %
1	Everyday	23	57.5
2	Weekly	10	25.0
3	Monthly	4	10.0
4	Never	3	7.5
	Total	40	100%

Table 3 shows the frequency distribution of laboratory waste disposal routine adopted in the university. The result shows that; Everyday disposal had a frequency count of 23 recording 57.5%. Items generated and disposed on weekly basis recorded a frequency count of 10 (25%). Monthly disposal had frequency counts of 4 and 10% while the class of NEVER disposed of because they are insignificant recorded 7.5%. This meant that, there are varying types of waste generated and their routine of disposal varies depending on their hazardous composition.

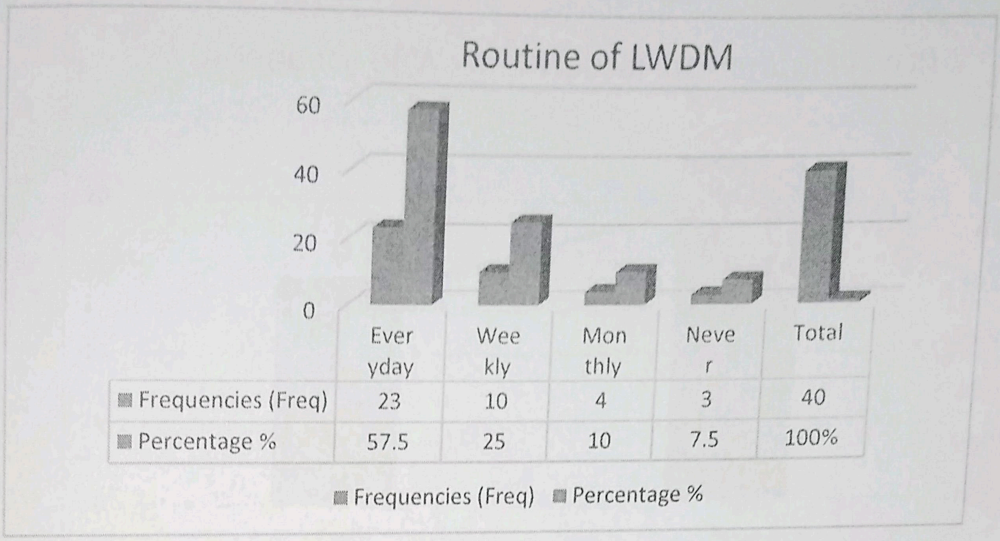


Fig 1: Analysis of LWDM Routine in the University

Figure 1 shows the chart on routine of LWDM in the University. The chart shows that daily disposal of waste generated had the highest frequency counts of 23 (57.5%). This indicated that most of waste generated are disposed-off daily probably to avoid contamination or risk associated with them.

4. Are there Laboratory Waste Disposal Incinerators adequate in the University?

Table 4: Frequencies and Percentages on adequacies Waste Disposal Incinerators in the University

Response	Frequencies	Percentages
Yes	15	37.5%
No	23	57.5%

Table 4 shows the analysis on students' view on the adequacy of the incinerators available in the University. Students were also asked whether there are Table 4 shows that there are no adequate number of incinerators for waste treatment in the university with a response rate of 23 [57.5%]. This meant that, there are no sufficient incinerators in the university.

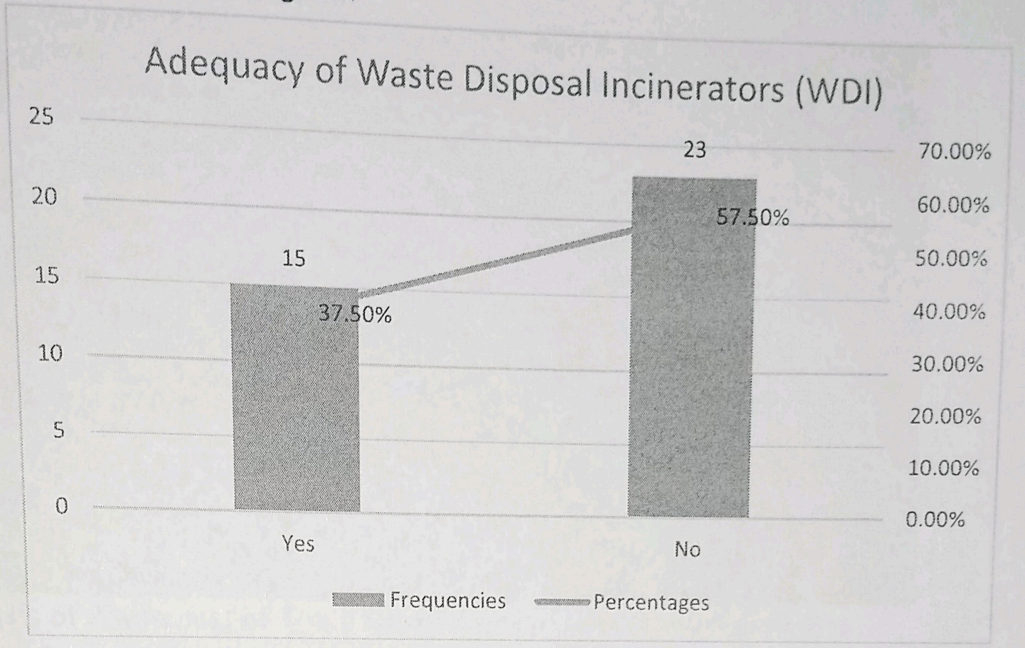


Fig 2: Adequacy of WDI

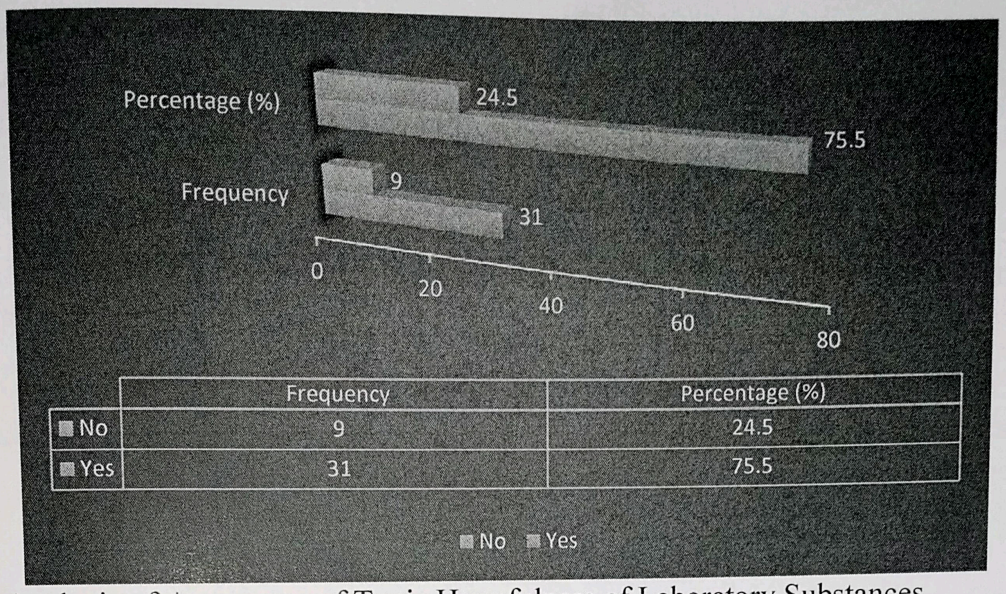
Figure 2 shows vertical bar chart on the adequacy of Waste Disposal Incinerators (WDI) in the University. Majority of the students indicated that the incinerators available are not adequate (23, 57.50%) while about 15 (37.5%) confirmed that the incinerators are adequate and just 2 (5%) were undecided.

5. Are you aware that University Laboratories can generate Toxic Harmful substances?

Table 5: Frequencies and Percentages on Awareness Laboratories generation of Harmful/Toxic Substances

Respondent	Frequency	Percentage (%)
Yes	31	75.5
No	9	24.5
Total	40	100.0

Table 5 shows the analysis of respondents perception of the kind of wasteful substances University laboratories are capable of generating. 75.6% of the agreed that the laboratories can generate toxic harmful substances that can cause severe injuries to human health while only 24.5% disagreed. This meant that majority of scoence education percieve the laboratories as capable of producing toxic harmful substances like gases capable of causing health injuries to students population if not properly disposed.



	Frequency	Percentage (%)
No	9	24.5
Yes	31	75.5

Fig 3: Analysis of Awareness of Toxic Harmfulness of Laboratory Substances.

Figure 3 shows horizontal bar chart of respondent awareness of laboratories capacity to produce toxic harmful substances. The chart shows that only 9 (24.5%) indicated that they are unaware that laboratory waste generates toxic harmful substances while 31 (75.5%) of science educations students indicated that they have awareness that Laboratories generates toxic harmful substances in the University.

Discussion of findings

Results of data collected and analyzed indicated that respondents hare awareness of 'Laboratory waste products can be harmful to human health' with a X score of 2.70 and standard deviation of 0.56. This meant that Laboratory waste products (LWP) can cause health related challenges. This finding is in consonance with the study of Licy et al. (2013) which shows that, most High School Students have awareness programme (P = 0.004) of the principles of waste management, and segregation of waste. Similarly, in a study conducted by Ponferrada et al. (2017) amongst Physics Undergraduate students on safety awareness showed that they are all aware of laboratory risk. And that the positive perception of the students could be reinforced by their chemistry and other sciences laboratory classes. The finding further suggests a good laboratory awareness and work environment sensitivity among tertiary students.

Gender factor does not indicate any difference in awareness of laboratory waste disposal management (LWDM) amongst undergraduate science education students in the University. The average Means (X) of the distribution for both male and female students was above the criterion Mean score of 2.50 on all items respondent to. Therefore, gender did not interfere with their awareness of LWDM. This finding was however not in consonance with study of Ponferrada et al. (2017) that determine whether gender plays a factor towards the level of safety awareness. The null hypothesis was established and tested by an independent t-test. There was a significant difference in the level of awareness between male and female students enrolled in Physics 10 ($t_{cal=2.28,} > t_{crit=1.65}$). The students of Physics 11 had similar level of safety awareness in the physics laboratory ($t_{cal} = 1.31 < 1.65$).

The finding on laboratory waste generated an d how is disposed off indicated that, waste products are disposed of daily which represents the views of most respondents on the questionnaire.

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