



## Assessment of Teachers' Knowledge and Practices on Laboratory Waste Disposal

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### Abstract

*In alignment with the United Nations Sustainable Development Goals 2030 (UN SDGs 2030), which emphasise the importance of ensuring education inclusivity and quality for all, this study investigated the quality of education in the context of science teachers' knowledge and practice related to laboratory waste disposal. Understanding the critical role that science teachers have in fostering a safe and sustainable learning environment, the research focused on the gap between the awareness and application of proper laboratory waste management techniques. Filling this gap is imperative not only for the well-being of the school community but also for the contribution to the broader goals of sustainable development outlined in the UN SDGs 2030. Consequently, this study assessed teachers' knowledge and practice in handling laboratory waste disposal. As a qualitative research, this study used a phenomenological design with semi-structured interviews using open-ended questions to gather data from 20 public science teachers from Santa Rosa City and Cabuyao City in Laguna Province as respondents. Regarding teachers' knowledge, three themes emerged, namely: (1) recycling techniques, (2) waste segregation and disposal, as well as (3) treatment of laboratory waste. However, the majority of science teachers admit that they have limited knowledge of how laboratory waste should be disposed of. They tended to apply basic knowledge of waste management that they already knew, despite being aware that laboratory waste should be treated differently from solid waste generated by our offices at schools. Teacher's practice on laboratory waste disposal involved three steps, including identification, segregation of laboratory waste, and laboratory waste management disposal. Unfortunately, all were found to be inadequate to maintain proper laboratory waste disposal at schools. Hence, this study highlights the need to enhance awareness and facilitate training on laboratory waste disposal among teachers in public schools. Specific training and education on laboratory waste management, treatment, and disposal are essential for teachers in public schools who work in laboratory settings. Regular monitoring and evaluations of teachers' laboratory waste disposal practices should also be implemented to ensure that they adhere to the proper procedures.*

**Keywords:** Science Laboratory; Waste Disposal; Teacher's Knowledge and Practices

### Introduction

In all schools, it is necessary to evaluate teachers' actions and knowledge regarding the disposal of laboratory waste. To foster a safety culture among teachers and students in the science laboratory, it is essential to set appropriate ethical norms and rules. Laboratory malpractice may be committed when a member of the laboratory staff, a technician, or even a teacher fails to oversee

the safety, accuracy, and precision of laboratory work (Ponferrada et. al., 2017). The byproducts (waste) of scientific experiments conducted at schools can be exceedingly toxic or hazardous to students' health and the environment; therefore, it is essential to learn how to dispose of such waste in accordance with safety laws. Liquid, gaseous, and solid waste products are unavoidable by-products of laboratory investigations. If these wastes are not

managed appropriately, they can contribute to environmental harm, pose health risks, and irritate students.

Waste generation and disposal have become increasingly problematic worldwide in recent decades (Starovoytova, 2018). According to him, how waste is managed, stored, collected, and disposed of will determine if the environment is clean, pleasant, healthy, and sustainable. Waste cannot be prevented in any way.

A secure classroom atmosphere can drastically improve both students' performance and learning quality. However, indiscriminate waste disposal by students and teachers who do not employ effective waste management practices pose a serious problem that could impede the educational philosophy of any country in the future.

A sustainable environment is necessary for the growth of the next generation of scientists who will drive our economy forward despite the collapse of the global economy. The adoption of poor waste management practices, mainly the procedures, in schools impedes sustainable growth on all fronts and contributes to deteriorate environmental and public health conditions, including air and water pollution.

Unfortunately, both earlier and even contemporary biological and physical science education curricula do not place sufficient focus on the acquisition of practical skills for the construction and operation of secondary school laboratories. That is the problem, even though science teachers are obliged to know how to maintain scientific laboratories operating efficiently.

Waste disposal management primarily consists of collection, transportation, and disposal. A comprehensive waste management strategy for a school could involve activities such as collecting, sorting/separating biodegradable from non-biodegradable materials, modifying, treating, and recycling waste (Licy, Vivek, Saritha, Anies, & Josphina, 2013).

The knowledge and practices of science teachers, who are the foundation of high-quality science instruction at the elementary and secondary levels, must be evaluated immediately. According to Abne et al. (2017), literature is essential for improving solid waste management. This will advance the methods for the disposal of solid waste, as well as the adoption of recycling solutions and information.

Future science instructors must have a thorough understanding of solid waste management to significantly contribute to environmental sustainability. Consequently, the goal of this study was to assess the attitudes and knowledge of teachers regarding the disposal of laboratory waste, particularly at two scientific high schools in Laguna.

The management style used by teachers in the lab has been declining. Khan and Raza (2018) examined numerous issues with managing school science laboratory as well as potential solutions in their article. The authors pointed out several significant problems, such as limited funding, inadequate training for laboratory staff, and a lack of suitable facilities and equipment.

Additionally, according to Khan and Raza (2018), maintaining school science laboratory requires efficient waste disposal. They emphasised that waste in research laboratory might take the form of chemicals, malfunctioning machinery, or even biological materials. These materials can create environmental problems, health hazards, and even legal obligations if they are not disposed of properly.

Another problem that impacts waste disposal in research laboratory is inadequate training for laboratory staff. Khan and Raza (2018) discovered that a large portion of laboratory staff lack knowledge of how to properly dispose of laboratory waste. Due to this lack of information, items may be disposed of improperly, posing risks to both the environment and human health.

Smith (2019) also emphasised the fact that many high schools do not have adequate waste management procedures, which could pose risks to both students and the environment. According to Patel and Patel (2017), many institutions also had poor laboratory waste management procedures, while Chen and Wang (2016) discovered that in China, many laboratories lacked the necessary equipment, and the staff members were not properly educated in waste management procedures.

This prompted the study to assess teachers' knowledge and practices of laboratory waste disposal because of what appears to be a lack of knowledge and practice for laboratory upkeep.

### **Research Questions**

The managerial culture among teachers in the lab has been deteriorating. Their attitude in using laboratories and their familiarity with proper disposal procedures for laboratory waste can be used to assess the managerial culture. The health risks caused by the waste towards people's lives and the environment are frequently ignored in unoccupied scientific laboratories or in mismanaged reaction solutions. This study assessed teachers' knowledge and practices of laboratory waste disposal because of a lack of managerial culture in upkeeping laboratory.

This study aimed to assess teachers' knowledge and practices in handling laboratory waste disposal. Specifically, it seeks to answer the following questions:

1. What is teachers' knowledge of managing laboratory waste disposal?
2. How do teachers practice handling laboratory waste disposal?
3. How do teachers handle proper laboratory waste disposal?

### **Methodology**

As qualitative research, this study used phenomenological design to gather data. The knowledge and practices of secondary school classroom teachers regarding laboratory

procedures are investigated. A phenomenological design is practical for identifying knowledge and practices of science teachers on laboratory waste disposal because it enabled the researcher to gain an in-depth understanding of the phenomenon, understand the teachers' perspective, remain flexible in data collection and analysis, as well as identify themes and patterns, gaps, and areas for improvement (Moustakas, 1994).

In this study, the interview method was employed within the framework of phenomenological patterns to elicit instructors' thoughts on the procedures utilized in science laboratories, especially concerning waste disposal. An extensive structured interview with open-ended questions served as the researcher's main strategy for collecting data. The interview approach allowed researcher to pose questions that are flexible, interactive, and encourage further conversation to reveal the experiences and meanings of the phenomenon. The population of this study consisted of 20 science teachers from Santa Rosa Science and Technology High School in Santa Rosa City and Pulo National High School in Cabuyao City, both from Laguna Province.

The instrument for data collection was an interview guide designed by researcher that underwent expert validation. The experts involved in instrument validation test were selected Science and English teachers. Consent forms were also provided before the conduct of the interview. Participants were informed about the study and were assured that they could withdraw at any point, even in the middle of the study, if any ethical issues arose.

### **Data Analysis**

Analyses of qualitative data were used to assess the research data. In this type of analysis, the data in a form of text was divided into smaller pieces (expressions, sentences, or paragraphs) and labelled. After that, the labels were grouped into themes

with a code name (Saldaña, 2016; Braun & Clarke, 2006; Miles & Huberman, 1994). The code name may be developed from participant comments, the researcher's explanations, or ideas found in the social sciences past research. Additionally, the quotations provided direct support for the conclusions reached during the investigation into the transferability of the work.

Each participant's responses were explicated into paragraphs and each paragraph was coded. The categories were used to organise the codes. Sub-themes were created by combining the collected categories into one coherent paragraph. As a result, the categories and sub-themes that would be included under the main topic were developed as shown on a table. Then, each

category and sub-theme were thoroughly discussed as the result of the study. Those results were backed by verbatim quotations from the participants' utterances to ensure the study's transferability. The participants' verbatim quotations were presented using code names.

## Results and Discussion

### Teachers' Knowledge on Managing Laboratory Waste Disposal

In this study, teachers' knowledge was classified into two categories: initial knowledge (pre-service teaching and 1-3 years of in-service teaching) and current knowledge (4 years to the present of in-service teaching). Upon analysis of the responses, Table 1 shows the common themes that have emerged.

**Table 1.** Teachers' Knowledge of Laboratory Waste Disposal.

Teacher's Knowledge	Themes
Initial Knowledge	Recycling
	Waste Segregation and Disposal
Present Knowledge	Treatment of Laboratory Waste
	Laboratory Waste Management Protocol

As shown, initial knowledge revolved around general knowledge of waste management and segregation. Those were evident from statements made by teachers during the interview when asked to share their knowledge or understanding of laboratory waste disposal before their in-service practice. Most responses were generic and have no direct relation to laboratory waste management. Responses such as: *"I would segregate materials accordingly (biodegradable, non-biodegradable, plastics, etc.)"* and *"I apply the 3Rs like reduce, re-use and recycle"* were common to all respondents. Those results were not surprising since no education course or subject specifically was given to the pre-service teachers regarding the proper methods to handle laboratory waste and its standard method of disposal. Although a majority of specialisation courses included laboratory, no course was offered to deliberately discuss about laboratory waste

management and disposal in a proper manner. Therefore, those results were not surprising. Even though the majority of specialised courses contained lab work, there was not a single course that specifically addressed how to manage and dispose of laboratory waste. Those may be inferred from recent legislation (CMO 75, s. 2017) and earlier legislation (CMO 30, s. 2004), which set forth the policies, standards, and requirements for bachelor's degrees in secondary education for all Teacher Education Institutes (TEIs) across the nation.

Interestingly, present knowledge of laboratory waste has evolved alongside knowledge of waste disposal. Most teachers admitted that they would refer to the Material Safety Data Sheet (MSDS) to know how to properly dispose of laboratory waste. The majority of science teachers admitted that they had limited knowledge of how laboratory waste should be disposed of. They

tended to apply basic knowledge of waste management that they already possessed despite knowing that laboratory waste should be treated differently from solid waste generated by our offices at schools. That

suggested that while the teachers had a basic understanding of waste treatment, they may need more information on the specific regulations and guidelines in their laboratory.

### Teacher's Practices on Laboratory Waste Disposal

As shown in Table 2, teachers' practice on laboratory waste disposal was categorised into three areas. The first concerned the identification of laboratory waste. Science teachers tended to identify the materials they use, assessing whether the materials were hazardous or not. In cases where they were unsure of its classification, they referred to the Material Safety Data Sheet (MSDS). Unfortunately, for biological experiments, some teachers admitted that they were not

familiar with biosafety levels, thus they were not aware of how to properly treat biological agents. Moreover, science teachers also admitted that they do not know how laboratory waste is supposed to be treated and disposed of, especially chemical waste, even though some of them were chemistry teachers. Although they are aware of the protocol that should be followed, they rarely know how to put them into practice.

**Table 2.** Teachers' Practices in Handling Laboratory Waste Disposal

Code	Responses
<b>Identification of Laboratory Wastes</b>	<p><i>I identify waste materials.</i></p> <p><i>I check the materials to see if they can safely be disposed of in the sink or in the trash can.</i></p> <p><i>I check the Material Safety Data Sheet (MSDS).</i></p> <p><i>I evaluate waste according to its degree of hazard.</i></p>
<b>Segregation of Laboratory Waste</b>	<p><i>I check whether the chemical is toxic or not.</i></p> <p><i>I used to separate the biodegradable materials from the non-biodegradable one.</i></p> <p><i>I tend to separate the broken glass from any chemical spillage.</i></p>
<b>Management of Disposal</b>	<p><i>I practice the 3Rs; reduce, reuse, and recycle.</i></p> <p><i>I would coordinate with my head teacher on how to dispose of hazardous materials or chemicals.</i></p> <p><i>I use small amounts and very low concentrations of chemical reagents.</i></p> <p><i>We just connect with the chemical disposal company and categorise our wastes using their guidelines.</i></p> <p><i>We just refer to the MSDS on how to handle the chemicals.</i></p>

This result is supported by the study of Kostov, P. & Kostova, P. (2020), which focused on laboratory safety and risk management in science education. They found that teachers lack knowledge and training in proper laboratory safety procedures and risk management. The study might also have highlighted the importance of providing teachers with training and resources to ensure the safety of their students in the laboratory.

The second area is the segregation of laboratory waste. Science teachers claimed that they usually check if the material is toxic or not, hazardous or non-hazardous, biodegradable or non-biodegradable, and chemical or solid waste. This practice helped them ensure that their students are safe from any potential harm and helps them decide how they will dispose of laboratory materials. They also mentioned separating broken glass from chemical spills, which is a good practice

for safety reasons. However, they also mentioned that when it comes to chemical waste, they did not know how to treat and dispose of it properly, indicating a need for more training in this area. This data is in line with the procedure set by Department of Education (DepEd) as stipulated in the DepEd Order (DO) No. 48, s. 2006, which emphasises the importance of safety in science laboratories and requires the proper safety measures, such as segregation, to be implemented to ensure the safety of students and teachers.

Teachers' practices on laboratory waste disposal vary depending on their specialisation or the subject being taught in the class. Science teachers with specialisations in Physics and Biology claimed that they were not aware of a chemical waste treatment since they did not use chemicals during laboratory classes. However, in cases where chemicals were needed, they separated toxic from non-toxic or limited the use of such chemicals to a minimum (low concentration) so that they can simply flush it down the sink. For biological waste, some teachers claimed that they would simply dispose of it with a label along with other waste/garbage or bury it in the soil.

Lee, Kim, & Kim, (2021) found that there are certain laboratory skills that are common among all science majors, such as basic laboratory techniques, safety procedures, and data analysis. However, there may also be field-specific laboratory skills that are unique to certain majors, such as techniques for handling radioactive materials for physics majors or techniques for handling live organisms for biology majors (Tan & Tan, 2019; O'Neil, 2019).

Last area is laboratory waste management disposal. Science teachers with administrative functions are tasked to coordinate with these authorities. On the other hand, it was found that science teachers did not know this practice of coordinating with the proper authorities in handling laboratory waste disposals. No existing

guidelines were found in schools that teachers could follow. One teacher mentioned that, "*Since there are no existing guidelines that they can follow, they would rely on private chemical disposal companies and would follow the guidelines set by these companies*". In cases where laboratory waste is piling up, they would coordinate with the local government unit, especially the City or Municipal Environment and Natural Resources Office (CENRO), to help the school dispose of it. They also mentioned using small amounts of chemical reagents and referring to the Material Safety Data Sheet (MSDS) for guidelines on handling chemicals. The teachers also stated that they connect with chemical disposal companies for the proper disposal of chemical waste but also mentioned that there are no existing guidelines that they can follow, indicating a need for more guidelines for laboratory waste disposal in their school. This was supported by researchers (Ancheta, 2017; Ioan, Onose, & Raluca, 2012; Perez, 2014; Paghastian, 2017; Sandham, 2014) which emphasized that waste management practice activities were minimal at the school environment.

The lack of knowledge and practices on laboratory waste disposal among teachers can have significant implications for environmental sustainability. Improper disposal of laboratory waste can lead to the release of hazardous materials into the environment, potentially causing harm to human health and the ecosystem. In addition, it can also contribute to pollution and the depletion of natural resources.

Furthermore, teachers play a critical role in promoting sustainable practices among students. If teachers lack knowledge and understanding of proper laboratory waste disposal procedures, they will not be able to effectively educate and guide students on how to reduce their environmental impact.

The lack of proper training and resources for teachers on laboratory waste disposal may also lead to non-compliance with regulations and laws governing waste management. This can result in penalties and fines for the

school, which can divert resources that could be used for other sustainable initiatives.

In short, the lack of knowledge and practices on laboratory waste disposal among teachers can harm the environment and human health and can impede the implementation of sustainable practices in educational institutions. Schools must provide teachers with the necessary training and resources to ensure that they can effectively manage and dispose of laboratory waste in a way that is compliant with regulations and promotes environmental sustainability.

Upon visiting the school laboratories, the researcher found that no one was assigned to the management of these laboratories; instead, laboratory maintenance was assigned to the school's janitor who did not know laboratory protocols. They are merely tasked with cleaning each laboratory room. Science teachers were also assigned to each laboratory for monitoring laboratory use only.

In summary, the study revealed that there is a gap in teachers' knowledge and practices on laboratory waste disposal, with many teachers lacking a thorough understanding of the proper procedures. This is a concern as it can lead to the improper disposal of hazardous materials, which can be harmful to the environment and human health.

## **Conclusion**

The results have shown that teachers' knowledge and practices on laboratory waste disposal are lacking. While general knowledge of waste disposal is important, it is not sufficient when it comes to managing, treating, and disposing of laboratory waste. Laboratory waste is unique and poses different risks and hazards compared to other types of waste. This requires specialised knowledge and practices to ensure the safe management, treatment, and disposal of laboratory waste. Therefore, it is essential for teachers in public schools who work in laboratory settings to have specific training and education on laboratory waste management, treatment, and disposal.

Without this specialised knowledge, they may not be able to effectively manage and dispose of laboratory waste, putting students, staff, and the environment at risk. Public schools need to provide teachers with the necessary training and resources to ensure that they have the knowledge and skills to safely manage, treat, and dispose of laboratory waste to protect the health and safety of students, staff, and the community.

In addition, the identification, segregation, and management of laboratory waste are crucial themes in ensuring the safe and compliant disposal of laboratory waste in public schools. The ability to properly identify laboratory waste is the first step in ensuring its safe and compliant disposal. Without proper identification, teachers may not be able to determine the appropriate method of disposal, which could lead to accidental exposure to hazardous materials or non-compliance with regulations.

Segregation of laboratory waste is also important to ensure that it is properly treated and disposed of in a way that protects the health and safety of students, staff, and the environment. Different types of laboratory waste may require different methods of disposal, and segregation ensures that the waste is handled and disposed of appropriately.

Proper management of disposal is also essential in ensuring the safety of students, staff, and the community. This includes knowledge of the regulations and laws governing laboratory waste disposal, as well as the appropriate methods for handling and disposing of various types of waste materials. Teachers should be trained to manage the disposal of laboratory waste in a way that is compliant with all relevant regulations and minimises the risk of accidents or exposure to harmful substances.

Public schools must provide teachers with the necessary training and resources in these three themes of identification, segregation, and management of laboratory waste disposal. This will help to ensure that

students and staff are protected and that the school is in compliance with all relevant regulations. Regular assessments and evaluations of teachers' laboratory waste disposal practices should also be implemented to ensure that they are adhering to the proper procedures.

In conclusion, this study highlights the need for increased awareness and training on laboratory waste disposal among teachers in public schools. Improper disposal of laboratory waste can have serious consequences for the environment and human health, and teachers play a vital role in promoting sustainable practices among students. Therefore, it is essential that teachers have a thorough understanding of the proper procedures for handling and disposing of laboratory waste, and that they receive regular training and resources to ensure that they can promote sustainable practices in the laboratory and school environments.

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