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Waste Management of High School Biology Laboratory in Yogyakarta City

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Abstract

The waste processing from the high school biology laboratory is minimally handled correctly by the laboratory manager. Laboratory waste remains hazardous to the environment and dangerous to health. Schools do not have reference standards in laboratory waste management (Biology laboratory), which has the potential to cause differences in managing laboratory waste. This study aims to determine the management of high school biology laboratory waste in Yogyakarta. This qualitative descriptive study involved laboratory heads and laboratory assistants from 3 high schools; the three schools were selected by random sampling. Instruments in data collection using questionnaires, interview guide sheets, and documentation. The questionnaire consists of 19 statement items. Data were analyzed by descriptive quantitative. The results showed that in both schools, namely Schools A and B, the percentage for laboratory waste management reached 64.71% (good). In comparison, School C, the percentage for laboratory waste management reached 82.34% (very good). The average high school biology laboratory waste management in Yogyakarta City is in a good category.

Introduction

Good laboratory management supports learning, observation, and scientific testing (Liu, 2023; Nurhadi, 2018; Susanti et al., 2020). Thus, supporting learning activities, research, and implementing the development of the theories studied (Daryanto, 2018). Laboratory management is not limited to the management of infrastructure and human resources but is also related to waste generated from activities in the laboratory. Every laboratory in a school should have good laboratory waste management so that practicum activities can be carried out smoothly (Hamidah, 2013).

Waste is unwanted by the environment and has no economic value (Marliani, 2014). From a chemical perspective, laboratory waste consists of organic chemical compounds and inorganic compounds. Waste with a specific concentration and quantity can hurt the environment, especially for human health, so it is necessary to handle the waste. Laboratory waste can be a by-product of practical experiments.

School laboratory waste from laboratory experiments can be toxic and dangerous to health and the environment (Bello, 2021). So, it is necessary to do proper handling in the waste treatment process. However, high school biology laboratory waste in Indonesia generally consists of organic waste produced from biological materials, so decomposing is easy (Widjajanti, 2009).

In general, processing laboratory waste, especially liquid waste, is only deposited in a holding pond before being discharged into the environment. In this case, the waste referred to is liquid waste originating from the washing of laboratory equipment which usually contains the organic matter used in the experiment. In general, liquid waste generated from laboratory processes is shallow compared to waste generated from industrial activities, so it is important to carry out adequate waste treatment (Azamia, 2012). Based on the substances contained in laboratory wastewater collectively and for a long time, if discharged directly into the environment, they will pollute the environment, damaging soil structure, threatening the survival of aquatic and terrestrial ecosystems, and impacting human health. Therefore, it is necessary to have liquid waste treatment (Audiana, 2017).

Knowledge about the characteristics of waste is needed to manage waste properly. The features of the waste are very dependent on the source of the waste and the activities that produce the waste. The type of equipment used can change from time to time depending on the activities carried out in the laboratory (Feng Zhu et al., 2015). Based on these conditions, this study seeks to provide information on waste management in high school biology laboratories in Yogyakarta.

Methods

This research uses a type of survey research with a qualitative descriptive method. A survey on biological laboratory waste management was conducted in 3 senior high schools (SMA) in Yogyakarta randomly from high schools with a accreditation and biology laboratories separated from other laboratories (such as physics and chemistry).

Data collection used a questionnaire containing 19 items regarding waste handling and processing. The waste handling and management questionnaire includes several variables: cooperation with waste management agencies, collection, and transportation of solid waste, liquid waste, B3 waste (hazardous and toxic materials), and waste from damaged or broken practicum equipment. In addition, interviews were conducted with laboratory managers. Data were analyzed by descriptive quantitative. The percentage of laboratory management uses equation 1.

$$Percentage(\%) = \frac{Score\ obtained}{Score\ max} \times 100\% \quad (1)$$

Table 1. Category of waste management

Interval (%)	Category
75 – 100	Very good
50 – 74	Good
25 – 49	Not good
0 – 24	Not very good

(Sugiyono, 2008)

Results and Discussion

Waste management must be an essential concern for high school biology laboratory managers. Research data regarding laboratory waste management from 3 high schools in Yogyakarta can describe efforts to handle and manage waste carried out by each school. Waste management data shows results in the good category (Table 2).

Table 2. Percentage of high school biology laboratory waste management aspects

School	Aspects of waste management assessed (%)				Total (%)
	Cooperation	Solid waste	Liquid waste	Damaged Practicum Equipment Waste	
SMA A	00.00	35.29	23.54	5.88	64.71
SMA B	11.77	35.29	11.77	5.88	64.71
SMA C	5.88	35.29	35.29	5.88	82.34

Based on Table 2 shows that waste management in Schools A and B is included in the "good" category. In comparison, School C is in the "very good" category. Laboratory waste management is an important part to consider in biology laboratory management. A suitable laboratory has several interrelated factors, such as sophisticated equipment, competent human resources, and good laboratory management support. Therefore, laboratory management is inseparable from laboratory activities (Indrawan, 2019).

Cooperation in managing Biology laboratory waste in three schools still needs to be improved. School A is still trying to handle waste independently, while schools B and C are trying to build cooperation with outsiders to manage waste. Laboratory management must consider concepts/principles related to the managed object (Lestari *et al*., 2017). All activities in the laboratory must have a waste disposal management plan, both non-hazardous and hazardous (Committee on Promoting Safe and Secure Chemical Management in Developing Countries, 2010).

In the aspect of solid waste has a higher percentage than other aspects. Biology practicums at the senior high school level tend to use plants or animals so that the waste produced is organic and can be disposed of or processed into compost. The three schools have special temporary shelters for laboratory solid waste. On the other hand, school A has tried to process laboratory solid waste into eco-bricks (Figure 1). Djatmikowati et al. (2020) stated that temporary waste storage containers must be made of materials that are strong, lightweight, non-rusting, easy to clean, and must be covered. In addition, waste management must identify waste and its hazards, collect and store waste properly, and dispose of waste properly (Maharani & Sasi, 2019).

Figure 1. Solid waste processing at the biology laboratory of School A

In the liquid waste aspect, School C has the highest score (Table 2). The liquid waste management in Schools A and C is by neutralizing the liquid waste before disposal. At School B, the liquid waste is not immediately neutralized but is first collected in special jerry cans. Liquid waste is neutralized utilizing filtration and absorption methods to remove the acid-base properties of the solution (Figure 2).

Liquid waste has characteristics that can be analyzed by chemical, physical, biological, and combination methods (Suharto, 2011). Liquid waste management can be done by two methods, namely, the method of filtration and absorption using natural materials that have been arranged sequentially. Before processing, the waste is collected first in the collection device. This storage device has two tanks for pre-processing and post-processing waste. The liquid waste processing and storage equipment is equipped with faucets and natural materials such as gravel, sand, palm fiber, activated charcoal, and zeolite as waste management tool. These materials are arranged sequentially, with the thickness used 5 cm, but for zeolite, the thickness is 10 cm. This aims to optimize the adsorption process. Each of these materials has insulation gauze to keep the mixture of components that make up the liquid waste disposal device. The addition of activated charcoal to this tool is intended to adsorb or absorb dissolved metals and dyes in liquid waste. The zeolite was activated using 1M HCL and then heated at 130°C to remove impurities and open the zeolite pore space to function more optimally as a zeolite adsorbent (Fitriyah, 2016). This liquid waste must be appropriately managed so that it does not pose a severe threat to the environment, human health, and threats to other organisms (Hakim & Hardianti, 2017).

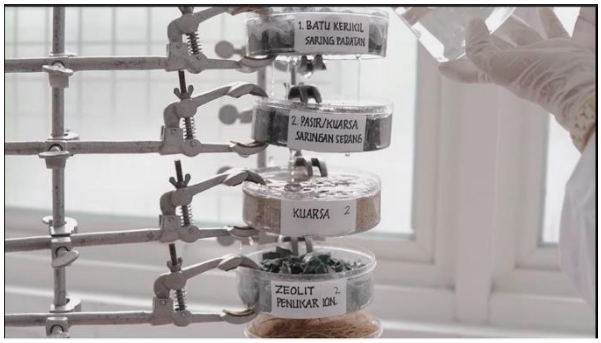

Figure 2. Processing of liquid waste from the biology laboratory at school A

Aspects of waste management as a broken practicum tool when schools have the same quality. Based on the interviews, information was obtained that there had never been any damaged (broken) practicum equipment waste. If it is damaged or broken, laboratory equipment made of glass cannot be disposed of carelessly. Mulyono (2019) revealed that glassware that has been broken or damaged, if disposed of carelessly, will be dangerous for animals and humans. Managing broken waste of laboratory equipment requires proper waste management practices to ensure that hazardous materials are disposed of safely (Peñaflor & Ong, 2022). Broken glass should be collected and disposed of in a separate container to avoid contaminating other waste (Bao-lin, 2014). Besides, Glass waste can be recycled to promote environmental safety in the laboratory. Handling laboratory waste is indeed the responsibility of the laboratory assistant. However, it is crucial to provide provisions to students before carrying out activities in the laboratory to reduce the risk of work accidents. So that when students do a practicum, they understand the standard operating procedures that apply in waste handling.

Conclusions and Recommendations

Laboratory waste management has been carried out well in all three schools. The absence of cooperation with parties outside the school to handle biology laboratory waste still needs to be a concern in the future. In addition, it is necessary to carry out further research in various schools to support this finding. As well as the need for student measurements related to concern and adherence to standard operating procedures, especially in handling waste.

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