Indonesian Journal of Biology Education
Vol. 7, No. 1, 2024, pp: 32-37
pISSN: 2654-5950, eISSN: 2654-9190
Email: ijobe@untidar.ac.id
Website: https://journal.untidar.ac.id/index.php/ijobe/index

Standard Operational Procedures for Organizing Practical Activities in High School Biology Laboratories in Yogyakarta City

Asti Dwi Pratwi[1], Adelia Maharani[2], Much Fuad Saifuddin[3*], Iin Syafani[4], Ade Jatra Alfariz[5], Ilmiyah Nurul Istiqomah[6], Etika Dyah Puspitasari[7], Destri Ratna Ma'rifah[8]
Department of Biology Education, Universitas Ahmad Dahlan, Indonesia
Email: [1]asti1900008069@webmail.uad.ac.id,
[2]adelia1900008058@webmail.uad.ac.id,
[3]fuad.saifuddin@pbio.uad.ac.id,
[4]iin1900008074@webmail.uad.ac.id,
[5]ade1900008071@webmail.uad.ac.id,
[6]ilmiyah1900008075@webmail.uad.ac.id,
[7]etika.puspitasari@pbio.uad.ac.id,
[8]destrirm@pbio.uad.ac.id
**Corresponding Author*

Article History
Received : 11 – 05 – 2023
Revised : 17 – 04 – 2024
Accepted : 02 – 05 – 2024

Keywords:
Good Laboratory Practice, Laboratory, Standard Operating Procedure

Article link

Abstract

The standard of operating procedure (SOP) is a laboratory activity method and must meet the criteria of good laboratory practice (GLP) and other stipulations of valid legislation. The article aims to establish ownership/lack of the SOP of a laboratory that has a public high school laboratory in the city of Yogyakarta. It uses descriptive research. The purpose of descriptive research is to describe images systematically. The research was conducted at Yogyakarta State High School in June 2022—data collection techniques via observation, interviews, and questionnaires. The forms of the instruments used were observation sheets, interview sheets, and checklists, where the instruments had been validated. Samples in this study are random sampling, SMA A, SMA B, and SMA C. This research subject is the head of a high school biology lab in Yogyakarta. The study showed that high school biology LABS A, B, and C already had the SOP implemented, but there was still a lack of it, and this led to increased safety principles. School A has as many as 9 SOPs, school B has as many as 10 SOPs, and school C has as many as 8 SOPs. Out of all three schools, only school B had SOP malfunction of lab equipment. Presumably, school B has the most complete SOP than schools A and C.

Introduction

Biology laboratories in schools have an important role in supporting biology learning outcomes both cognitively and psychomotorically. Practical activities in laboratories help students gain science experience (Bahtiar & Dukomalamo, 2019), facilitate conceptual growth and increase students' understanding of biological concepts (Wallace et al., 2003), and laboratory classes provide a unique learning environment that encourages the process of scientific discovery and development of transferable skills such as critical thinking and problem solving (Gibbons et al., 2020). Therefore, biology laboratories in schools must have good management to support achieving biology learning objectives.

Management in a biology laboratory involves organizing and coordinating various aspects of a biology laboratory to ensure smooth operations and optimal results. This includes overseeing laboratory resource utilization, ensuring safety and security protocols are adhered to, managing human resources effectively, and implementing systems for data management (Craig et al., 2017; Gobaw & Atagana, 2016;

Tobing et al., 2021). Standard Operating Procedures (SOP) are the basis that can be used to ensure that safety and security protocols are adhered to by every human resource in the laboratory, and they are the key to laboratory management running well, effectively and efficiently.

SOP is fundamental in managing laboratories in schools. SOPs are established protocols that describe the steps that must be followed in various laboratory processes (Athanasiou, 2017). These procedures are developed based on experience and organizational best practices, ensuring an efficient and standardized workflow (Petrigna et al., 2021). In addition, SOPs are very important for maintaining a quality management system, such as good laboratory practice guidelines (Gumba et al., 2019; Kessler & Raggam, 2012). The existence of SOPs in the laboratory plays a role in helping laboratory management to be more focused so that it can help carry out practical activities.

The existence of SOPs in a biology laboratory at school is important in the management of a school biology laboratory. However, the lack of information regarding the condition of SOPs in senior high school (SMA) biology laboratories means that the evaluation of laboratory management is still limited to an inventory of tools and materials based on regulations from the Ministry of National Education of the Republic of Indonesia. It is hoped that this research can contribute to knowing the condition of SOPs in biology laboratories in high schools so that it can be a form of evaluation of the management conditions of biology laboratories in high schools based on SOP aspects.

Methods

This research uses a qualitative descriptive approach to describe Standard Operating Procedures for biology laboratories in high schools. The research was conducted at a public high school in Yogyakarta in June 2022. Data was collected through biology laboratory observations, questionnaires, and interviews with the head of the high school biology laboratory. Data was obtained from a randomly selected sample of schools from Senior High Schools in Yogyakarta, which have A accreditation, so SMA A, B, and C were obtained as samples. The subjects of this research were the heads of high school biology laboratories from each sample school. Data were analyzed descriptively qualitatively with a focus on describing the existence of Standard Operating Procedures for high school biology laboratories.

Results and Discussion

The laboratory is a place to develop knowledge in the form of practicum based on the theory that has been obtained in learning (Agustina, 2017). Laboratory management must have standards (Standard Operating Procedures) that are used as a reference in managing the laboratory. Standard Operating Procedures (SOP) play a role in encouraging and mobilizing a group to achieve organizational goals (Manlea, 2017). Cahyaningrum et al. (2019) revealed that SOP is a written guideline for carrying out an activity. Based on the data obtained, the three sample schools have different conditions related to SOP.

Standard Operating Procedures (SOP) at SMA A

Based on observations, the biology laboratory has 9 SOPs, which are archived and posted in several open places such as the practical table, walls, and entrance to the laboratory room. The biology laboratory at SMA A has implemented SOPs, including the use of the laboratory, preparation of practicum schedules, implementation rules, Occupational Health and Safety (K3), use of tools and materials, procurement of tools and materials, inventory of procurement of goods, loan of equipment and proposal for research permits. All SOPs are implemented and controlled by the laboratory assistant.

Based on the interview results with the laboratory head, the practicum schedule was scheduled by the subject teacher, sometimes a separate schedule between learning and practicum hours. Arranging laboratory use schedules (practicum) is important to regulate laboratory circulation to reduce disruptions and optimize existing resources (Sanapiah et al., 2019). The primary use of school biology laboratories is to facilitate learning activities in the form of practicums, while research activities are carried out outside learning hours so that they do not interfere with the practicum schedule.

Work safety SOPs in the laboratory are listed in several places, such as tables and doors, so that students can easily read them. Students are always reminded of the SOPs during practical activities. Apart from that, there are also SOPs for preventing work accidents and work safety measures when practical accidents occur. Prevention is carried out by always providing information and direction regarding SOPs in the laboratory, such as guidelines for using tools and dangerous chemicals. First aid equipment is also available to anticipate work accidents during practicum. Students are required to wear laboratory coats when carrying out practical work in the laboratory room. Students must use personal protective equipment

such as masks and closed shoes during practical activities, while the use of gloves varies according to practical activities; if necessary, gloves must be used.

SOPs for laboratory use are always applied in practicum implementation. Every student must know the practical rules while in the laboratory. Information about the rules and regulations is posted in several places, such as the practical table, walls, and entrance to the laboratory room. If the rules are violated, sanctions will be given in the form of a warning or expulsion from the laboratory. The school has an SOP for borrowing equipment and proposing research permits in the laboratory. Teachers who are interested in using laboratory space must contact the laboratory assistant first so that the laboratory assistant can prepare the tools and materials needed. Apart from that, students who want to borrow items in the laboratory must fill out an item borrowing book, then permission to do research in the laboratory is permitted but it is prioritized for learning purposes first (outside of learning hours).

Based on the results of the observations, the laboratory space is supported by adequate facilities. However, the fan or AC facilities do not function properly, so students often feel uncomfortable. Apart from that, the hand washing place is not functioning because it was not used during the COVID-19 pandemic, so it is still abandoned. Laborans always check the condition of tools and materials. If there is a practicum schedule, tools and materials will be prepared the day before the practicum. Teachers and laboratory assistants always teach students the SOP regarding the use of practical tools and materials in the laboratory so that using the tools during practical work remains safe and optimal and no work accidents occur. Studies emphasize the importance of individuals (students) complying with safety regulations and fostering a culture of occupational safety and health to minimize the risk of accidents (Sudiana, 2022; Trisna et al., 2021). Accidents in laboratories are often caused by inadequate knowledge of safety measures, unsafe attitudes, and inappropriate practices (Hussein & Shifera, 2022). Teaching related to SOPs for the use of practical tools and materials becomes a safety knowledge program, which can function as an accident prevention measure, thereby reducing the frequency of accidents (Liu et al., 2020). Inventory of procurement of goods in the laboratory is carried out according to applicable SOPs. The equipment in the biology laboratory is inventoried by the biology laboratory, but the inventory of practical materials is carried out together with the chemistry laboratory, especially chemicals because the materials for biology practicum are mostly fresh, so they cannot be stored for long. Procurement of tools and materials is carried out at certain times according to the schedule and practical needs. Every year, the head of the laboratory submits a request to the school regarding the procurement of equipment and materials in the laboratory. Budgeting for chemicals and tools by the school. Each chemical has a label containing information about the chemical, including product identity, chemical composition, and hazard identification.

SOPs in biology practicums in schools play a very important role in ensuring efficient and effective laboratory management (Suseno et al., 2022). If there is an SOP and it is implemented well, every activity in the laboratory will be clearer and more conducive, thus supporting the implementation of the practicum. The development and implementation of SOPs in practicums have been proven to increase the efficiency of practicum implementation in high school laboratories (Handayani et al., 2020).

Standard Operating Procedures (SOP) at SMA B

Based on observations made in the SMA B laboratory, 11 SOPs were archived and posted in several open places, such as cupboards and walls of the laboratory room. The SOPs implemented include SOPs for laboratory use, procurement of laboratory equipment and materials, damage to laboratory equipment, preparation of practicum schedules, implementation rules, Occupational Health and Safety (K3), use of tools and materials, inventory of procurement of goods, borrowing equipment and proposing research permits. Based on the results of the interview with the head of the laboratory, the SOP for using the laboratory includes setting up a practicum schedule. Practicums in the laboratory are carried out according to the subject schedule so that there will be no schedule clashes, and the use of the laboratory can be well controlled. Meanwhile, the use of laboratories other than for practicums is determined based on the priority order for registering laboratory loans.

The K3 SOP is attached to the wall of the laboratory room. SOP K3 contains information on preventing work accidents and work safety measures that need to be taken when work accidents occur in the laboratory. So, to prevent work accidents, SOPs are needed. Although it cannot stand alone as a variable determining the success of laboratory biosafety, the existence of SOPs and SOP evaluation can guarantee the quality, consistency, and integrity of laboratory examinations (Ezzelle et al., 2008). When carrying out practicum, the teacher will warn students to always be careful and make observations according to the applicable SOPs to avoid work accidents. The SOP contains recommendations for wearing laboratory coats during practical activities. However, in its implementation, students who do not wear laboratory coats are still allowed to carry out practical work. Apart from wearing laboratory coats, students are encouraged to

use personal protective equipment such as gloves, masks, and closed shoes when carrying out practical activities.

Laboratory use is carried out in accordance with applicable SOPs. There are rules that students must know and obey when using the laboratory room to carry out practicums. The rules and regulations are posted on the laboratory wall so that students can read them. There are also rules and regulations that are archived, and usually, they will be socialized by the teacher before carrying out the practicum. If there are students who violate the applicable rules, they will receive a warning from the subject teacher. The distribution of practicum schedules follows the lesson schedule. The practicum schedule is set by the teacher; then, the teacher will report to the laboratory so that the tools and materials that will be used are prepared. Borrowing of equipment and laboratory space is carried out in accordance with the applicable SOP for borrowing equipment and proposing research permits. Based on interviews, loans are usually only for practicum purposes. For scientific work or other things, it is rare, but if there is, you will be given a permission letter to use it.

Based on the results of the observations, the SMA B Biology laboratory has sufficient space for practicum students to use. The laboratory room has sufficient area to accommodate 27 students, in accordance with what is regulated in the Minister of National Education Regulation Number 24 of 2007, namely that the laboratory room must be able to accommodate students with a minimum capacity of 3 study groups and a maximum of 27 study groups. The location of the laboratory is quite strategic and easy to find. According to Indrawan (2015), the location of the laboratory room is in the middle of the classroom and is in the same block as the classroom. With such an arrangement, the time to move from the classroom to the laboratory room is shorter. The air circulation in the room is good; there are circulation blowers on the walls and windows. Hand washing equipment is complete and there is a sink in front of the door, and there are several in the laboratory. Before using the tools, the laboratory assistant will ensure that the tools and materials can be used properly. Electrical equipment and cables are in good condition and safe.

The SOP for the use of practical equipment and materials in the laboratory applies during the practical implementation. Procurement of tools and materials is carried out according to the SOP for inventory of goods procurement in the laboratory. If the equipment is damaged or the materials have expired, they will be thrown away beforehand; the material will be stored first, then waited until it is full, and then delivered to the Environmental Service. The expiry date of chemicals is usually long for high school students, especially when chemicals that are dangerous or have high concentrations are less used. There is a certain time for procuring practical equipment and materials in the laboratory. Purchasing chemicals is carried out by laboratory assistants. Each chemical has an identity label and information on the substance. Chemical storage is grouped according to type; for example, acid solutions are collected in a fume cupboard; if they are in powder form, then they are collected in the same way. Each laboratory chemical must be labeled and stored according to its class by placing it in a fume cupboard (Sari et al., 2018).

Standard Operating Procedures (SOP) at SMA C

Based on observations made in the SMA C laboratory, there were 8 SOPs archived and posted in several open places, namely on the walls of the laboratory room. The SOPs implemented include SOPs for laboratory use, procurement of laboratory equipment and materials, preparation of practicum schedules, implementation rules, Occupational Health and Safety (K3), inventory of procurement of goods, borrowing equipment, and proposing research permits. Laboratory management at SMA C is borne by the head of the laboratory, assisted by laboratory assistants. Practical schedules and activities are regulated and fully borne by the subject teacher concerned, whereas biology practicums will be borne by the Biology teacher. Based on the results of the interview with the head of the laboratory, the preparation of the person in charge of the laboratory use schedule protocol is always carried out so that it is well organized. Prioritization of the use of laboratory space is prioritized according to the order of registration submitted by the teacher.

Occupational Health and Safety (K3) SOPs are applied in every practicum implementation in the laboratory. The work safety SOP is in the form of a writing board attached to the wall of the laboratory room. Apart from that, teachers always explain the K3 SOP before carrying out practicum to reduce the risk of work accidents during experiments and observations. Teachers who are competent and knowledgeable in laboratory safety can reduce the frequency and severity of accidents in laboratory facilities (McKim & Saucier, 2013). Work safety measures are taken by requiring students to wear laboratory coats when in the laboratory. Every practitioner tries to use gloves, masks, and shoes during practicum, but laboratory assistants do not provide gloves in the laboratory.

The use of laboratory space and the facilities and activities therein are regulated in accordance with the applicable SOP for laboratory use. There are rules and regulations that students must obey while in the laboratory area. The teacher will read the rules that apply before carrying out the practicum. The rules

board is also attached to the laboratory wall so that students can read independently. Students who violate the rules will be given a warning first, and if they violate more than three times, they will be summoned by the guidance and counseling teacher for guidance. Practicum schedule arrangements follow the lesson schedule set by the subject teacher. School C laboratory has an SOP for borrowing equipment and proposing research permits in the laboratory if someone applies for a permit. Tool borrowing is only for practitioners who will do the practicum. Meanwhile, proposals for research permits can go through the Administration and Laboratory departments. SOPs can be a reference in carrying out activities in the laboratory (Fikri, 2020; Rifa'i et al., 2021), including laboratory assistants checking and ensuring that tools and materials can be used properly before the practicum is carried out.

Inventory of procurement of goods in the laboratory is carried out in accordance with applicable SOPs. Before carrying out procurement, what must be prepared is what experiments will be carried out, what tools and materials will be purchased with clear specifications, purchasing procedures, whether funds are available or not, and the implementation of the purchase. There is no specific time for procuring tools and materials, procurement of tools is carried out if it is deemed necessary and required for equipment rejuvenation. Usually, procurement is carried out every three months. Purchasing chemicals is carried out by officers or laboratory assistants. Each chemical is labeled, including product identity and chemical composition, and no information is given to identify the dangers. Chemical storage is placed in one cupboard and grouped based on solid and liquid.

Conclusions and Recommendations

Based on the results of this research, the existence of SOPs for each laboratory is very important because it will support effective and efficient laboratory management. Biology laboratories at SMA A, B, and C have several complete SOPs including: use of the laboratory, procurement of laboratory equipment and materials, preparation of practicum schedules, Occupational Health and Safety (K3), inventory of tools and materials, and borrowing equipment. However, there is still a need for the government to standardize SOPs so that they become a reference for every biology laboratory in high school, and regular evaluations can be carried out to support the achievement of student competency in working in biology laboratories.

Acknowledgement

We would like to thank SMA Negeri 5 Yogyakarta, SMA Negeri 10 Yogyakarta, and SMA Negeri 11 Yogyakarta for providing permission to collect observation and interview data for this research.

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