



IMPLEMENTATION OF STANDARD OPERATING PROCEDURES IN BIOLOGY PRACTICUM HIGH SCHOOL

Alfrista Novalia Putri, Febrina Ayu Wulandari, Arum Wilianti Suparno, Arista Mukti Khasanah, Tri Eva Rahmadani, Much. Fuad Saifuddin*, Etika Diah Puspitasari

Program Studi Pendidikan Biologi Fakultas Keguruan Ilmu Pendidikan, Universitas Ahmad Dahlan
Jl. Ringroad Selatan, Kragilan, Tamanan, Kec. Banguntapan, Kabupaten Bantul, Daerah Istimewa Yogyakarta 55191

*Corresponding author: fuad.saifuddin@pbio.uad.ac.id

ARTICLE INFO

Article History

Submission	2022-07-14
Revision	2023-03-29
Accepted	2023-04-09

Keywords:

Standard Operating Procedure (SOP)
Biology Laboratory
Biology Education

ABSTRACT

The Laboratory is a room or places equipped with tools and materials suitable for teaching science or implementing science practicum. Laboratory management in terms of organizational structure, activities, and facilities needs to be evaluated to increase awareness of the effectiveness of science learning and increase laboratory safety to the optimum level. This paper aims to determine 1) Standard Operating Procedures and 2) Obstacles in school SOP management. The research method used was descriptive exploratory. The data were collected by conducting interviews, observation, and documentation. The data analysis technique was carried out in descriptive qualitative. The results showed that the Biology Laboratory preparation at three Bantul Regency schools already had a Standard Operating Procedure (SOP). However, some schools have not fulfilled the SOP properly. Of the three schools observed in school C, there is no SOP for storing tools and practicum materials. School B SOP that has not been posted in the open, SOP for occupational health and safety, SOP for procurement of tools or practicum materials, and SOP for purchasing chemicals. School A does not have SOP posted in the open, SOP for storing tools or practicum materials, and procurement of tools or materials.

INTRODUCTION

The laboratory is a room or place to carry out practical activities supported by the components of laboratory equipment, and there is a complete infrastructure (Solikhah &

Puji, 2020). Learning resources in the laboratory include development, procurement, research, and service functions. Optimizing learning can be supported through practical activities in the laboratory. Practicum activities in the laboratory can provide students with experience using laboratory equipment appropriately and efficiently (Abrahamsson & Almarlind, 2012). This is supported by the laboratory operational standards adjusted to the applicable Good Laboratory Practice, including setting work procedures, personnel training, data recording, and documentation (Annisa, 2022; Hasugian, 2016). Preparation of the SOP adapted to improve laboratory quality. SOP must be easy to read, understand, implement, and account for, amended according to evaluation results or certain circumstances.

Laboratory Management requires SOP according to ISO 17025. Sailendra (2015) states that SOP is a guide that can be used to ensure the operational activities of an organization or company run smoothly. SOP contains written instructions regarding the implementation process, including the implementation time, activity steps, and others. According to Dirnagl (2012), SOP aims to guide and standardize work procedures to ensure data reliability and integrity so that performance is carried out more effectively and efficiently. Authority and responsibility, as a document in assessing the work process in case of an error or suspected malpractice.

Practicum is one of the activities carried out in the laboratory. Mastika (2014) claims that practicum activities will greatly affect efforts to improve students' abilities in skills and observations, which are a means of training in using laboratory equipment. Proper laboratory management is needed to carry out practicum activities according to the objectives of implementing the practicum. Laboratory managers must have competence in conducting practicums at the preparation, implementation, and evaluation stages. The right SOP can facilitate the implementation of practicum and can maximize the usefulness of the laboratory and the resources in it (Supriyanto, 2019).

The effectiveness of using the laboratory is generally proven by achieving practicum objectives. However, not all schools can carry out practicums by applicable standard operating. According to Wiratma and Subagia (2014), learning in the laboratory often encounters several problems: laboratory management, which includes procurement, use, and maintenance processes. Problems in the process of procuring tools and materials might be caused by the inaccuracy of the tools and materials needed, errors in the

operation of tools and materials as well as the process of maintaining tools and materials, which includes the arrangement of material tools in the laboratory (Wiratma & Subagia, 2014). Another problem is technical ambiguity in SOP (Dirnagl, 2012). This causes the use of the laboratory to be inefficient. According to Supriyanto (2019), to maximize laboratory management, SOP is important in carrying out quality practicum activities. Therefore, this research is important to determine how complete SOP have been implemented in biology laboratories.

MATERIALS AND METHODS

The method used in this research was descriptive-exploratory, with three schools as the sample. The sampling using purposive with consideration of state schools with accreditation "A" and the presence or absence of a biology laboratory. This research uses state high schools because they have sources of government funding.

Data from this study were obtained by conducting structured interview techniques with the head of the laboratory and the biology teacher, observation, and documentation of the biology laboratory. The interview process was conducted to obtain data from the Head of the Laboratory and the Biology teacher by asking several questions regarding the availability (the types of SOPs owned) and management of SOP.

The data analysis technique in his study were observation and interviews using structured interview techniques. A structured interview is a procedure for gathering information in which several questions are asked coherently and systematically that have been prepared using an interview sheet regarding SOP in schools (Hakim, 2013).

RESULTS AND DISCUSSION

The result was an interview with the head of the high school of biology laboratories. each school has a SOP. School A has some SOP, namely procurement of tools and practical materials, use of laboratory equipment, and Occupational Health and Safety. All biology teachers were involved in preparing several SOPs, having previously received training in preparing SOPs organized by the Subject Teacher Working Group (MGMP) of biology. SOP have been prepared for the laboratory since 2020, updated on June 12,

2021. SOP management is carried out by the head of the laboratory and the laboratory assistant.

School A has some problems with implementing Occupational Health and Safety SOP in practicum activities. students do not use laboratory coats because the school does not have a sufficient budget to provide laboratory coats. Thus, to avoid the risk of a major accident during the practicum, the teacher takes into account and considers using safe materials when students are practical without using personal protective equipment such as laboratory coats, masks, and gloves.

Personal protective equipment protects from work accidents and exposure to biological contamination. Compliance behavior using complete Personal protective equipment (masks, laboratory coats, and gloves) are all human activities that are aware of safety and health but cannot be observed or seen by outsiders. Gloves can protect students from infectious materials and microorganisms in the hands of students. The continuous presence of infectious diseases characterizes the spread of infectious microbial agents. The emergence of microbes tends to be present in fairly large populations (Anderson & Stang, 2017). So, the need for use of personal protective equipment is applied to prevent nosocomial infections (Nurdiani, 2019).

The SOP for using laboratory equipment emphasizes that students must wash the tools used when using laboratory equipment, especially glassware, pipettes, and surgical instruments. Before doing the practicum, students prepare the tools and materials used in the laboratory by filling out a loan form. Then the laboratory assistant prepares the tools and materials that will be needed, records their use, and rearranges them after they are used (Dewi et al., 2019).

In the SOP of procuring tools and practicum materials, the head of the laboratory always checks all equipment regularly once a week because it has become routine. If any practicum equipment is damaged, the subject teacher reports to the head of the laboratory. Then followed up with data updating of laboratory equipment and materials. School A does not yet have a waste management SOP, so if any practical equipment is damaged, as well as practicum materials that have expired, they will be stored and placed in a cupboard in the corner of the room.

Separation of this waste is done to protect yourself from sharp objects such as broken glass and prevent environmental pollution. The procedure for purchasing

chemicals is that every teacher of biology, chemistry, and physics subjects conveys the practical material that will be carried out. Then, each subject teacher submits the materials needed for practical activities to the head of the laboratory. Manlea (2017) states the important thing to note is that before carrying out activities, at least a day before the subject teacher practicum, fill out a tool request format and submit it to the laboratory assistant. If the materials used are not available, the head of the laboratory will submit them to the field of facilities and infrastructure. The head of the laboratory follows the rules by paying a set price and limiting the number of purchases from the school budget.

The second interview was conducted with the manager of the biology laboratory at School B. The interviews showed that school B already has an SOP prepared by the deputy head of the curriculum, among others 1) SOP of Occupational Health and Safety, 2) managed tools and material laboratory, and 3) laboratory and practicum management. The Regulation of the Minister of Education and Culture Number 24 of 2007 is the reference for preparing SOP. The SOP that regulates the biology laboratory is put together as a written document and kept privately by the school.

The SOP of Occupational Health and Safety, every practical student must wear a lab coat while in the laboratory. Under its function, a laboratory coat is an essential tool for protecting the body from splashes of harmful chemicals (Rahmantiyoko et al., 2019). Gloves and masks are also things that must be worn by students in participating in the practicum. The consequences that students must bear if they do not wear these three components are that they are not allowed to take part in the practicum and carry out the practicum independently with materials prepared by students. In contrast, the school has prepared the equipment (in SOP of laboratory and practicum management).

The implementation of independent practicum by students is based on the principles of observation, planning, and investigation in the problem-solving process (Rahmatika & Alimah, 2014). This principle can be implemented if students have understood the theory and practical work procedures. Therefore, the laboratory manager distributes the practicum manual at the beginning of the new semester, which must be read before the practicum is carried out. It aims to make students more prepared to face the practicum. Students' readiness in practicum can be seen in the procedural activities carried out by students, such as using materials, washing laboratory equipment (glasses, pipettes, and surgical instruments), then arranging them to their original places. Improper procedures

in the implementation of practicum can cause work accidents. First Aid for Accidents (P3K) prepared in the laboratory of School B is quite complete, which contains medical equipment to anticipate threats from potential hazards that are not realized and result in death (Mahardhika et al., 2019).

The SOP of managed tool and material laboratory is to arrange a biology laboratory to store practical tools and materials. Practical materials are stored in the refrigerator. Following its function, the refrigerator stores practical materials at a temperature of -15°C (Handayati et al., 2014). The laboratory manager does not limit the type of material deposited as long as the material is related to practical activities. The storage period for materials related to the practicum is a maximum of three days. If the practitioner does not take the practicum material for more than the specified time, then the consequence is that the laboratory manager discards the material. Each tool and material deposited is labeled with a description of the group's name and date of entry to avoid confusion with materials deposited by other practitioners. If any tools or materials deposited are damaged, the practitioner is fully responsible for replacing the damaged materials or tools.

Inspection of tools and practicum materials is carried out regularly. The checking was carried out by the manager of the biology teacher laboratory and assisted by several other teachers. The checking is carried out once a year, starting with the tools and materials used for practical needs, and an inventory is carried out once a month. Practical tools and materials must be grouped according to function and type, then placed in a special place. These checks can support practical activities in the laboratory (Anggraeni et al., 2013). Procedures must be carried out if there is damaged laboratory equipment, namely data collection in which data on damaged equipment must be reported to the infrastructure section. The infrastructure party will report to the office regarding replacing damaged equipment or goods. Dropping of tools or materials is sometimes not as needed, so the action taken is to accept the drop of equipment provided by the service and store it properly. Storage is carried out in a place adapted to the material. The storage room is a dark room, a specimen room, a special room for chemical storage, and an administration room (Gunawan, 2019). Maintenance of laboratory equipment or materials is carried out to maintain the condition of the equipment so that it is not damaged and maintained in good condition so that it is ready to be used for practicum activities in the laboratory.

The third data collection was conducted at School C. Interviews were conducted with Biology teachers and laboratory managers. Based on the interviews conducted, School C already has several SOP that is applied, especially in the Biology Laboratory. Each laboratory manager attends training to prepare SOP that must be carried out. Several SOP has been implemented, including the SOP for the use of laboratories, the SOP regarding the maintenance of tools and practicum materials, the SOP for disposing of waste, and the most recent SOP, namely the SOP regulating COVID-19. The SOP that has been made is put together in the form of written documents, and several SOP is pasted. SOP is updated once a year. However, the SOP for the Biology Laboratory has not been updated for the last two years. This is due to a pandemic that requires restrictions on activities in the Biology Laboratory.

Implementing the practicum must comply with the SOP for health and safety to avoid work accidents in the Biology Laboratory. The student practitioners must use lab coats, gloves, closed shoes, and masks to protect themselves. If a student violates, sanctions are in the form of a reduction in value. Personal protective equipment (PPE) must be used appropriately and correctly (Sukwika & Kartikasari, 2021). The Biology Laboratory in school C has provided first aid kits and has a UKS room that meets national standards so that it can be used in the event of a minor work accident. In addition, School C also cooperates with the Hospital in the event of a severe work accident. To avoid this, students are given an understanding of theory and work procedures before the practicum is carried out so that students are better prepared to face practical activities and can reduce errors and work accidents. Laboratory safety is the responsibility of both laboratory managers and students (practical). Various efforts need to be made so that the possibility of work accidents can be prevented (Adillah et al., 2021).

The laboratory must have an SOP for storing tools and materials used as work standards for a laboratory assistant. Safekeeping tools or practicum materials according to procedures can minimize workplace accidents. Tools or materials that are saved must be labeled with the name of the material or tool, the name of the depositor, and the date the goods began to be deposited. Labeling the name of the material serves to determine the nature of the material so that the remaining materials used do not pollute the environment and avoid work accidents (Lasia et al., 2020). In addition, the SOP for storing tools and materials must also contain the expiration date of the stored chemicals.

The procurement of tools or materials also needs to be considered. The procurement of tools and materials is very important in the laboratory so that recording and estimated data can be processed in a structured and neat manner (Yusuf et al., 2019). Periodic checking of practicum tools and materials according to the interests and needs of the laboratory. Checks are carried out at least once a month in terms of expiration and the condition of tools and practicum materials. Data collection on the condition of laboratory equipment is recorded in the equipment breakdown book. If there is damage to equipment during the practicum activity, the procedure that needs to be carried out is by recording the damage to the equipment, both type and amount, then an evaluation is carried out, which will be reported to the infrastructure section.

The infrastructure also plays a role together with the treasurer in purchasing chemicals. The cost of purchasing chemicals comes from the Bantuan Operasional Sekolah (BOS) Fund and school committee funds. Laboratory assistants usually purchase chemicals at the beginning of the new school year, with no limit on the number of chemicals purchased. Laboratory assistants ensure the use and urgency of these chemicals in practical activities.

Table 1. Result of observation SOP in school

No	Indicator	School A	School B	School C
1	Schools Have an SOP Regarding Laboratories	√	√	√
2	Schools Have Written Documents Setting SOP	√	√	√
3	SOP posted in the open	-	-	√
4	Rules Installed in The Open	-	√	√
5	There is a Laboratory Room Management Structure	√	√	√
6	There is a work health and safety SOP	√	√	√
7	There is an SOP for the safekeeping of Practical Tools or Materials	-	√	√
8	There is an SOP for the Procurement of Practicum Tools or Materials	-	√	√
9	There is an SOP for Purchasing chemical	√	-	√
Percentage		55.55%	77.77%	100%

Table 1. shows that the laboratories with SMA/MAN in Bantul Regency do not all meet the Laboratory SOP. This can be seen in the data that shows that 100% percentage of school C does not have an SOP for storing practical tools and materials. 77.77% of school B has not been posted in the open, and an SOP for occupational health and safety, SOP

for procurement of tools or practicum materials and SOP for purchasing chemicals. 55.55% of school A does not have SOP posted in the open, SOP for storing tools or practicum materials, and procurement of tools or materials. This needs to be a note for the management of the School Biology laboratory that has been made more applicable to each SMA/MAN in Bantul Regency. A well-managed biology laboratory in accordance with SOP can be used as a means of supporting the learning process. The results of this study are used as input in laboratory management in accordance with SOP so that it can reduce the risk of work accidents and laboratories can be used effectively in the learning process.

CONCLUSION

Based on the results and discussion above, it can be concluded that the preparation of the Biology Laboratory in three schools in Bantul Regency already has an SOP. However, some schools still do not meet the SOP properly. For example, some schools have not attached SOP in open areas, most of the rules have been installed in open areas, there is no SOP for storing tools or practicum materials, no procurement of tools or materials, and no SOP for purchasing chemicals. Laboratory managers must understand the SOP regarding managing biology laboratories in schools. This is because a good understanding of laboratory SOP can help maximize the function of the biology laboratory so that students can learn to conduct experiments in the laboratory effectively.

ACKNOWLEDGMENT

Thank you to SMA N 1 Banguntapan, SMA N 2 Bantul, and MAN 2 Bantul for their willingness to participate in this research, especially to the head of the biology laboratory and laboratory assistants who have taken the time to serve as resource persons.

REFERENCES

Abrahamsson, M., & Almarlind, P. (2012). A study of inter-rater agreement when teachers assess students' laboratory skills in science. the 13th annual AEA-Europé Conference, Berlin, Germany.

- Adilah, M., Setiadi, A. E., & Kahar, A. P. (2021). Analisis standarisasi laboratorium biologi Sekolah Menengah Atas (SMA) di Kota Pontianak (The analysis of standardization of biology laboratory at senior high school in Pontianak). *Jurnal Ilmiah Didaktika: Scientific Media of Education and Teaching*, 21 (2), 195-207. <http://doi.org/10.22373/jid.v21i2.5995>
- Anderson, N., & Stang, H. (2017). Promoting Good Laboratory Practices for Waived Infectious Disease and Provider-Performed Microscopy Testing. *Clinical Microbiology Newsletter*, 39(23), 183–188. <https://doi.org/10.1016/j.clinmicnews.2017.11.001>
- Anggraeni, A., Retnoningsih, A., & Herlina, L. (2013). Pengelolaan laboratorium biologi untuk menunjang kinerja pengguna dan pengelola laboratorium biologi SMA Negeri 2 Wonogiri. *Journal of Biology Education*, 2(3), 303-311. <https://journal.unnes.ac.id/sju/index.php/ujbe/article/view/3091>
- Annisa, V. (2022). Good laboratory practice (GLP) in then European Union. *Indonesian Journal of Pharmaceutical Education*, 2(1), 1-9. <https://doi.org/10.37311/ijpe.v2i1.11781>
- Dewi, D. A. K. D. S., Sastrawidana, D. K., & Wiratini, N. M. (2019). Analisis pengelolaan alat dan bahan praktikum pada laboratorium kimia di sma negeri 1 tampaksiring. *Jurnal Pendidikan Kimia Undiksha*, 3(1), 37-42. <https://doi.org/10.23887/jjpk.v3i1.21162>
- Dirnagl, U. (2012). Standard operating procedures (SOP) in experimental stroke research: SOP for middle cerebral artery occlusion in the mouse. *Nature Precedings*. <https://doi.org/10.1038/npre.2012.3492.3>
- Gunawan, I. (2019). Managemen pengelolaan alat dan bahan di Laboratorium Mikrobiologi. *Jurnal Pengelolaan Laboratorium Pendidikan*, 1(1), 19-25. <https://ejournal2.undip.ac.id/index.php/jplp/article/view/9082>
- Hakim, L. N. (2013). Ulasan Metodologi Kualitatif: Wawancara Terhadap Elit. *Aspirasi: Jurnal Masalah-Masalah Sosial*, 4(2), 165-172. <https://dprexternal3.dpr.go.id/index.php/aspirasi/article/view/501>
- Handayati, A., Christyaningsih, J., & Rini, T. (2014). Uji stabilitas Pooled Sera yang disimpan dalam freezer untuk pemantapan mutu internal di Laboratorium Klinik. *Jurnal Penelitian Kesehatan*, 12(1), 55-60. <http://journal.poltekkesdepkes-sby.ac.id/index.php/JPK/article/view/412>
- Hasugian, A, R. & Lisdawati, V. (2016). Peran standar operasional prosedur penanganan spesimen untuk implementasi keselamatan biologi (Biosafety) di Laboratorium Klinik Mandiri. *Media Penelitian dan Pengembangan*, 26 (1): 1-8. <https://garuda.kemdikbud.go.id/documents/detail/434753>
- Lasia, I.K., Budiada, I.K., & Widiasih, N. N. (2020). Peningkatan keselamatan kerja di laboratorium melalui pelatihan penggunaan bahan berwawasan lingkungan. *Jurnal Widya Laksana*, (9)1, 19-29. <https://ejournal.undiksha.ac.id/index.php/JPKM/article/view/21434>

- Mahardhika, M. B., Yudiarti, D., & Muchlis, M. (2019). Perancangan kotak P3k berdasarkan aspek visual di sarana olahraga Bandung (studi Kasus Gor Saparua). *eProceedings of Art & Design*, 6(2), 2917-2925. <https://openlibrarypublications.telkomuniversity.ac.id/index.php/artdesign/article/view/10137>
- Manlea, H. (2017). Evaluasi pengelolaan laboratorium IPA SMP dan SMA di Kabupaten Belu, TTU, TTS dan Malaka. *BIO-EDU: Jurnal Pendidikan Biologi*, 2(1), 3-5. <http://jurnal.unimor.ac.id/JBE/article/view/514>
- Mastika, N. (2014). Analisis standarisasi Laboratorium Biologi dalam proses pembelajaran di Sma Negeri Kota Denpasar. *Journal Program Pascasarjana Universitas Pendidikan Ganesha* (4): 1-10. https://ejournal-pasca.undiksha.ac.id/index.php/jurnal_ipa/article/view/1077
- Nurdiani, C. U. & Krianto, T. (2019). Kepatuhan penggunaan alat pelindung diri (APD) di laboratorium pada mahasiswa prodi diploma analis kesehatan universitas MH Thamrin. *Jurnal Ilmiah Kesehatan*, 11(2): 88-93. <http://journal.thamrin.ac.id/index.php/jikmht/article/viewFile/72/71>
- Rahmatika, F., & Alimah, S. (2014). Pengembangan lembar kerja siswa berbasis Search, Solve, Create, and Share pada praktikum mandiri materi Mollusca dan Arthropoda. *Journal of Biology Education*, 3(3), 330-337. <https://journal.unnes.ac.id/sju/index.php/ujbe/article/view/4533>
- Rahmantiyoko, A., Sunarmi, S., Rahmah, F. K., Sopet, S., & Slamet, S. (2019). Keselamatan dan keamanan kerja laboratorium. *IPTEK Journal of Proceedings Series*, (4), 36-38. <http://iptek.its.ac.id/index.php/jps/article/view/6119>
- Sailendra, A. (2015). Langkah-langkah praktis Membuat SOP. Trans Idea Publishing.
- Sholikhah, R., & Suci, P. H. (2020). Pengembangan SOP (Standart Operational Procedure) Laboratorium Dalam Rangka Optimalisasi Fungsi Laboratorium Pada Program Studi Pendidikan Tata Busana UNNES. *TEKNOBUGA: Jurnal Teknologi Busana dan Boga*, 8(2), 152-160. <https://journal.unnes.ac.id/nju/index.php/teknobuga/article/view/29082>
- Supriyanto, S. (2019). Peningkatan kemampuan guru biologi dalam melaksanakan pembelajaran sesuai Standar Operasional Prosedur (SOP) laboratorium melalui bimbingan berkelanjutan di SMA Binaan Kabupaten Kendal semester 1 tahun pelajaran 2017/2018. *Majalah Ilmiah Inspiratif*, 4(07). <http://jurnal.unpand.ac.id/index.php/INSPI/article/view/1219>
- Sukwika, T., & Kartikasari, S. E. (2021). Disiplin K3 melalui pemakaian alat pelindung diri (APD) di laboratorium kimia PT Sucofindo. *VISIKES: Jurnal Kesehatan Masyarakat*, 20(1), 41-50. <https://doi.org/10.33633/visikes.v20i1.4173>
- Wiratma, I G. L., & Subagia, I W. (2014). Pengelolaan Laboratorium Kimia pada SMA Negeri di Kota.
- Yusuf, M. M., Irianto, I., & Djalil, S. (2019). Aplikasi Pengolahan Data Alat dan Bahan

Kimia Laboratorium Kimia Sekolah Tinggi Teknologi Industri Bontang. AL-
ULUM: JURNAL SAINS DAN TEKNOLOGI, 4(2), 6-13. [https://ojs.uniska-
bjm.ac.id/index.php/JST/article/view/1973](https://ojs.uniska-bjm.ac.id/index.php/JST/article/view/1973)