

## Quality of Biology Laboratory Infrastructure and Facilities in High School

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### Abstract

*Practicum is one of the essential learning activities for students psychomotor and fosters scientific attitudes in students. Therefore, adequate laboratory infrastructure is needed. Biology laboratory standards are contained in the regulation of the Minister of National Education No. 24 of 2007 concerning Standards for Educational Facilities and Infrastructure. The descriptive qualitative research was conducted at School A, School B, and School C, using data collection techniques such as observation and interviews. The study results indicate that laboratory facilities and infrastructure, including infrastructure, facilities and Biosecurity Level 1, follow the standards set in the regulation of the Minister of National Education No. 24 of 2007. Based on the research that has been done, the most suitable facilities and infrastructure according to the standards of regulation of the Minister of National Education No. 24 of 2007 are School B. Fulfillment of standards can support the smooth running of practicum. Besides, schools must keep raising standards to a higher level.*

**Keywords:** *Biosecurity level 1; Laboratory infrastructure; Laboratory management*



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### INTRODUCTION

The field of natural sciences (IPA), especially biology learning, is a science that demands proof between the theory obtained and the actual reality related to scientific learning (Inayah et al., 2020; Mahmudah et al., 2021). The process standard, according to the regulation of the Minister of Education and Culture No. 65 of 2012 concerning the Standards for the Primary and Secondary Education Process, states that the characteristics of the primary and secondary learning process are focused on a scientific approach or (scientific), integrated thematic and applied thematic based on research (discovery/inquiry learning). This requires teachers to improve learning based on scientific approaches, including practicum (Agustina & Ningsih, 2017). Learning science,

including biology, cannot be separated from practicum because practicum is part of science (IPA) (Cahyani et al., 2021; Irda Wahidah et al., 2022; Ramadhan & Suyanto, 2020). Through the practicum, students can experience themselves, follow a process, observe an object, analyze, ascertain, and draw conclusions from a particular object, situation, or technique (Ardiansyah et al., 2023).

If the components in the practicum meet the minimum laboratory standards, then the entire practicum process will run well. An example of this component is the laboratory room. The laboratory is where experiments and investigations are carried out (Emda, 2017). Could it be concluded that the laboratory is often referred to as a place in a building with walls and roof barriers and contains the tools and materials used in the practicum? In biology learning, open and closed spaces and classrooms or unique rooms can be used as laboratories.

A laboratory in biology learning is essential because it can provide opportunities for students to find and prove a theoretical study obtained from the teacher in the classroom (Miyamoto et al., 2019). Standards in laboratories have been regulated in the Ministry of National Education No. 24 of 2007 concerning facilities and infrastructure in laboratories. The Biology Laboratory has an essential position because the learning process in the laboratory covers three domains at once: cognitive, affective, and psychomotor (Ibrahim et al., 2021; A. D. Y. Inayah et al., 2020; Paxinou et al., 2020). Laboratory classes in biology offer a unique environment that fosters scientific discovery, technical skills development, critical thinking, problem-solving, creativity, and communication skills (Gibbons et al., 2020).

Aspects that distinguish this research from previous research are Biosecurity Level-1 (BSL-1) which was observed in the biology laboratory of SMA/MA in Bantul Regency. BSL-1 is a laboratory used to prove disease-causing agents that are not too dangerous to human health and can reduce potential hazards to laboratory members and the surrounding environment. Examples of microorganisms include *Escherichia coli*, *Bacillus subtilis*, Gumboro virus, and viruses' infectious canine hepatitis. The design requirements of BSL-1 must have: (1) There are entrances and exits, (2) Stainless steel hand washing basins, (3) Work clothes/laboratory coat racks, (4) Easy-to-clean workspace, (5) Room waterproof, (6) furniture that is sturdy and not easily weathered, and (7) windows are equipped with insect and dust filters (Manuaba, 2016).

This study aims to determine the suitability of the biology laboratory of SMA/MA following the laboratory standards listed in the regulation of the Minister of National Education for facilities and infrastructure Number 24 of 2007 and BSL level 1, from several SMA/MA in Bantul Regency, Yogyakarta City. The subject of this research is the biology laboratory at schools A, B, and C. The object of research is the facilities and infrastructure and the suitability of BSL-1 by the standards in the regulation of the Minister of National Education. The importance of research on facilities and infrastructure is also supported by previous research conducted by Harahap et al. (2022), which found that learning biology, a science, really needs practicum to complete students' understanding. Suitable practicum activities can be carried out with standard laboratory facilities. Munarti and Sutjihati (2018) stated that one of the essential facilities and infrastructure in schools is a laboratory. This is because the function of the laboratory in

education is to carry out demonstration practices, experiments, and scientific development, as well as a place to train students' skills.

## **METHOD**

This research is qualitative descriptive research. The selection of this method is based on the consideration that the data to be collected is related to the completeness and quality of facilities and infrastructure based on the regulation of the Minister of National Education No. 24 of 2007 concerning facilities and infrastructure in the laboratory, the observed laboratory facilities and infrastructure include space, furniture, props, tools and ingredient test, media education, and out-of-stock use. The criteria of BSL-I: 1) Entrance and exit doors, 2) Stainless steel hand washing basins, 3) Work clothes/laboratory coat racks, 4) Easy to-clean workspace, 5) An airtight room, water, 6) Sturdy and not easily weathered furniture, 7) Windows equipped with insect & dust filters, and 8) Availability of first aid kits (Manuaba, 2016).

The information was obtained directly from the head of the laboratory and laboratory assistant at the Bantul Regency Senior High School. The population of this study was SMA or MAN in Bantul. The sampling technique used is random sampling. Randomization was done using a population of A-accredited State of Senior High School SMA/MA in Bantul Regency. Then, the samples used in public schools managed by the government were initial schools A, B, and C. Data collection techniques are interviews and observations; the instruments used are interview sheets and observation sheets. Validation is carried out by a validator consisting of 2 lecturers in laboratory management courses. Because the research method is qualitative, data analysis is carried out qualitatively, describing each research result.

## **RESULTS AND DISCUSSION**

The observations and interviews with the head of the laboratory and biology laboratory in SMA/ MA in the Bantul district showed some differences in the conditions of the biology laboratory facilities and infrastructure. Interview observations and observations of biology laboratory facilities and infrastructure in this study were adjusted to the Minister of National Education regulation for facilities and infrastructure No. 24 of 2007 and BSL level 1. Two supervisors carried out the validation for laboratory management courses. The area of the three schools meets the minimum standard (Table 1).

The biology laboratory building at School C is separate from the main school building. The laboratory is just adjacent to the principal's room. Based on observations, the location of the laboratory building is very strategic to get sunlight so that the laboratory has good lighting and air circulation. The importance of lighting installations in laboratories is also, according to Parera et al., (2018), that room lighting, especially in workplaces such as laboratories that do not meet specific requirements, can worsen vision because if the lighting is too large or too small, the pupil of the eye must try to adjust the light received by the eye. The intensity of lighting is an essential aspect in the laboratory because various problems will arise when the quality of the intensity of laboratory lighting

does not meet the standards set. The size of the biology laboratory is by the regulation of the Minister of National Education No. 24 of 2007. The area of the laboratory practicum is 80 m<sup>2</sup>. The width of the practicum room is 8 m<sup>2</sup>, and the length is 10 m<sup>2</sup>. The storage space area for the biology laboratory of School C is 40 m<sup>2</sup>. The width of the storage space is 8 m<sup>2</sup>, and the length is 5 m<sup>2</sup>. The No of study groups per class is 20 students. Based on the regulation, the minimum ratio has been met.

**Table 1.** The observation of laboratory infrastructure based on the regulation minister of national education No. 24 2007

School	Laboratory Space Area	Standard by regulation	Decision
School A	Biology laboratory ratio 4 m <sup>2</sup> /student. Room area laboratory 120 m <sup>2</sup> including storage space. With a laboratory room width of 8 m <sup>2</sup>	The minimum area of laboratory space is 48 m <sup>2</sup> , including space storage and preparation of 18 m <sup>2</sup> .	Qualify standard minimum
School B	Laboratory space area 126 m <sup>2</sup> , Including room storage and laboratory workspace	The minimum width of the laboratory biology is 5 m <sup>2</sup> .	Qualify standard minimum
School C	Laboratory space area 80 m <sup>2</sup> Including storage space with wide room laboratory 8 m <sup>2</sup>		Qualify standard minimum

School B has met the good criteria based on the results of observations of the infrastructure, especially in terms of furniture. The quality of the tables and chairs is complete and can be used for practicum and learning in the laboratory. Meanwhile, at schools A and C, the laboratory space has been converted into a classroom, so many pieces of furniture do not match, and some are even unfit for use due to damage. Meanwhile, the three schools need to increase the number and improve the sink/sink quality. A good sink is important because it is used to wash hands and tools from dirt and chemicals to meet laboratory work safety (Li, 2023; Roberts et al., 2020). Furthermore, the availability of teaching aids such as body skeleton models, plant and animal preparations, the pictures of human organs, animals, and plants in the three schools have met the standard criteria of the National Education Ministry with complete equipment. However, the props and human skeleton models are damaged.

In terms of experimental tools and materials, overall, schools A and B are in a good category and are suitable for practical use. However, several tools are not yet available, or the amount does not match the ratio of the number set by the regulation of the minister of nat. Meanwhile, the number of experimental tools and materials at School C remains incomplete. The head of the laboratory explained that the experimental tools and materials had not been re-equipped because the practicum had not been carried out at this time due to the pandemic. Aspects of educational media in the three schools follow the standard: the blackboard follows the size and number. The blackboard is also white, located in the middle of the laboratory room, and maintained so students can see the blackboard. The aspect of consumables in the three schools has met the standard ratio. The liquid and solid materials have been separated and maintained properly. So, from the observations and interviews, aspects of consumables already meet the standards.

The provision or purchase of tools is carried out periodically once a year, while the purchase of materials is carried out periodically for 6 months. The procedure for purchasing tools and materials is checking or collecting data on the necessary tools and materials, then submitting them to the head of facilities and infrastructure. After the tools and materials arrive, an inventory is always carried out. According to [Indrawan et al., \(2018\)](#), realizing smooth, practice-oriented learning requires quality and standardized tools and materials. Maintenance of tools and materials, as well as laboratory space, is also one of the determinants of the success of activities in the laboratory. The ideal laboratory should be equipped with various facilities, and laboratory workers can facilitate implementing practicum activities in the laboratory ([Arora et al., 2021](#)).

**Table 2.** Observation Results of Laboratory Facilities

Aspect	Observation Result		
	School A	School B	School C
Furniture	The criteria for the furniture have been met with the appropriate amount. However, the furniture quality is poorly maintained because it is rarely used during the pandemic.	The furniture criteria have been met with the appropriate amount. However, the furniture is lacking due to lack of not being used during the pandemic.	The criteria for the furniture are complete, but much of the furniture is not maintained, and some have been damaged.
Props	The condition of the teaching aids is good, with the number of available teaching aids following the regulation criteria.	The props are in good condition, and the number of props has been fulfilled.	The existing props follow the predetermined amount of the regulation minister of national education and good condition.
Tools and Ingredient Test	The tools and materials for the experiment are in good condition and have met the regulation criteria, but the available quantities are limited.	Experimental tools and materials are in good condition, but some tools are not yet available, and the amount is not met.	The tools and materials in the laboratory are appropriate, some tools are not maintained and damaged. The available materials, quantity, and types are fulfilled, but some have expired.
Media Education	Educational media in the form of blackboards and stationery in condition and quantity good and the size is already the right fulfill criteria with regulation.	Educational media in the form of blackboards is in good condition, and the number and size have met the criteria.	Educational media such as blackboards and stationery in good condition and size amount with the minister of national education regulation.

Aspect	Observation Result		
	School A	School B	School C
Out-of-Stock Use	Ingredient finished use is neatly stored on the appropriate shelves and cabinets in a ratio that is still according to the provisions	Consumables have met the ratio defined and are stored neatly in good condition, and complete.	Ingredient finished use is neatly stored in the closet, but the cupboard is not fully qualified.

Based on Table 3, the results of observations regarding Biosecurity Level-1 (BSL-1) in three SMA Bantul City biology laboratories, the three laboratories have been standardized according to the BSL-1 criteria. The criteria for entrance and exit at all schools have been met, namely having 2 doors that function separately between the entrance and exit doors. The criteria for sinks only at School B are already made of stainless steel, while the sinks at School A and C are still coated with ceramic, and the hand washing basin at School A is no longer suitable. It is recommended that the sink (sink) be available in each laboratory in sufficient quantities. Each sink needs to be equipped with a water faucet, and it is not recommended to use porcelain or cast stone for sinks because it is feared that it is very risky to cause laboratory equipment made of glass to break when washed. Near the sink, it must also be equipped with liquid laundry soap and drying tissue (Garbaccio & Oliveira, 2013; Sisunandar, 2015). The biology laboratories of schools B and C do not have storage lockers, while the storage lockers at the biology laboratory of school A are under each student's desk. The biology laboratories at the three schools are included in workspaces that are easy to clean.

**Table 3.** The observation-based BSL-1

School Name	Criteria								Decision
	1	2	3	4	5	6	7	8	
School A	√	-	√	√	-	√	-	√	Standardized
School B	√	√	-	√	-	√	-	√	Standardized
School C	√	-	-	√	√	√	√	√	Standardized

Note: √: Fulfil; -: Not fulfil

Aspects of a watertight room in the biology laboratory of three schools already have a watertight biology laboratory room. The furniture in the biology laboratories of the three schools is solid; most of the furniture is made of strong wood, and some is made of iron and stainless steel. For the maintenance of the equipment itself, which is carried out by the laboratory, namely by immediately reporting to the facilities and infrastructure section if furniture must be replaced because it is fit for use. If the student damages the practicum equipment caused by the student, the student is subject to sanctions to replace the tool. According to Law No 36 of 2009 concerning Health, tool maintenance is an inspection and checking of tools that is carried out regularly to keep the tools in good condition or at least reduce the risk of damage to the tools, as well as the age of the tools in good condition so that they can last a long time.

The next criteria regarding windows and ventilation in the three laboratories are in good and sturdy condition. However, the windows and ventilation in the biology

laboratory of schools A and B are equipped with glass and do not have insect and dust filters. Unlike the windows and ventilation of the biology laboratory at School C, it is equipped with insect and dust filters. The lighting for the laboratory room is also very good, and it gets full sunlight. Then the availability of first aid kits in the three laboratories has been met, it is just that in the laboratories of Schools A and B, there are no fire extinguishers. School C has a Light Fire Extinguisher (APAR) in the laboratory, but the fire brigade team does not check the APAR regularly. The fire extinguisher in school C is not known whether it is still functioning. Work safety applied in the laboratory is that students must wear laboratory coats, shoes, gloves, and masks. If students do not follow these rules, they will not be allowed to participate in the practicum. The outside of the laboratory is equipped with CCTV to monitor the environment around the laboratory to keep it safe and conducive. Safety in the laboratory is the responsibility of all parties, managers, and users. Therefore, everyone involved is expected to have an awareness of workplace safety. Safety in the laboratory is the responsibility of all parties, managers, and users, therefore everyone involved is expected to be aware of workplace safety. Efforts to maintain work safety include efforts always to prevent the possibility of accidents when working in the laboratory (Adilah et al., 2021; Husna et al., 2023; Mendoza et al., 2019; Sudiana, 2022). Schools often experience difficulties or obstacles in meeting facility standards following ministry regulations due to regulations on the procurement of laboratory facilities which take a long time. Apart from that, there is a lack of control from the ministry regarding implementing these regulations.

## **CONCLUSION**

The results of observations and interviews at Schools A, B, and C show that these three schools have a biology laboratory that is in the good category. This shows the quality of the infrastructure and the completeness of the infrastructure in the form of (1) furniture, (2) teaching aids, (3) experimental tools and materials, (4) educational media, and (5) consumables. Based on the research that has been carried out, the three schools have met the minimum laboratory standards based on the Minister of National Education regulation no 24 of 2007. In addition, School B has the complete facilities and infrastructure following these regulations. Conditions of BSL-1 in the three schools have not been fulfilled optimally, so it is necessary to continue to improve according to existing developments.

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