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Article

Evaluation of Facilities and Biology Laboratory Management in Modern Islamic Boarding Schools: A Case Study at Pondok Pesantren Darunnajah

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Abstract: This study aims to assess the completeness of facilities and infrastructure as well as the management of the biology laboratory at Pondok Pesantren Darunnajah, South Jakarta, in order to improve the quality of science learning. Using a qualitative descriptive method, data were collected through direct observation, interviews with one teacher and one laboratory technician, and the collection of documents related to laboratory facilities and management. The findings indicate that the laboratory is equipped with supportive facilities, including technological devices such as computers and CCTV. From a management perspective, the laboratory is organized in a structured manner, with well-defined procedures for equipment borrowing, regular evaluations, and the procurement of tools and materials for practical activities each semester. However, limitations in the number of practical sessions and the absence of training programs for laboratory staff remain challenges that must be addressed to ensure sustainability and innovation. The results suggest that laboratories in Islamic boarding schools hold significant potential to support interactive and meaningful science learning if supported by effective management and continuous human resource development.

Keywords: biology laboratory; Islamic boarding school; laboratory management; facilities and infrastructure; science learning

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1. Introduction

Science learning at the Senior High School (SMA) level, including in Islamic boarding schools (pesantren), requires an integration of theoretical and practical aspects. This aligns with the need to integrate science and religion into a unified system [1]. Laboratory activities are an inherent component of biology learning [2]. In this regard, biology laboratories serve as one of the key facilities and infrastructure that play an essential role in supporting practice-based learning. A laboratory may take the form of an enclosed room, an open space, or a specially designed chamber for conducting research and scientific experiments [3]. Through laboratory activities, students can develop their scientific skills, such as observation, measurement, and direct analysis of concepts [4]. Consequently, both cognitive and practical learning objectives can be achieved more effectively [3].

The importance of laboratories as educational facilities and infrastructure has been emphasized in government policy. Ministry of Education and Culture Regulation No. 24

of 2007 mandates that every senior high school must be equipped with laboratories furnished with adequate tools and instructional materials [5]. However, supervision of laboratory completeness is necessary [6]. This underscores that minimum standards are a critical foundation for ensuring an effective and high-quality learning process. The availability of facilities and infrastructure that meet minimum standards serves as a key indicator in assuring the quality of educational activities [7], as school facilities and infrastructure are essential components of educational management that support the smooth implementation of teaching and learning [8]. Therefore, it is crucial for every school to pay close attention to the standardization of facilities, including laboratories [9].

Nevertheless, despite some schools having well-equipped laboratory facilities and infrastructure, their utilization remains suboptimal. On the other hand, several other schools still face limitations in facilities and infrastructure to support practical activities [4]. One study revealed two major challenges experienced by teachers in utilizing laboratories, namely the lack of practical equipment and insufficient teacher training in laboratory management [10]. The merging of science laboratories with other subjects, inadequate space, and non-compliance with standard area requirements also pose significant challenges [11]. In fact, laboratories are often used merely as storage rooms rather than as spaces for student exploration and experimentation [12].

In response to these limitations, teachers have initiated creative efforts by providing alternative media and practical materials, such as utilizing classrooms or the surrounding environment and employing simple materials, which have been shown to foster student creativity and cultivate a scientific culture [13]. However, such approaches are temporary in nature and cannot fully substitute the function of an ideal laboratory. Therefore, the provision of adequate and proper laboratory facilities remains an urgent need to support high-quality practical learning. This highlights the importance of focused attention on effective laboratory management [14].

Weak laboratory management can hinder teachers from designing effective laboratory activities. This situation leads to minimal student engagement in practical work, which should be an essential component of the learning process. In contrast, improved laboratory management can enhance the effectiveness of laboratory organization and utilization [15]. This is supported by findings indicating that optimal use of laboratory facilities can strengthen conceptual understanding, foster scientific attitudes, and improve students' skills [16]. Laboratory experiments also enable students to develop a deeper understanding of scientific concepts and principles [17]. Moreover, the availability of complete practical equipment significantly influences the effectiveness of learning [18].

Several previous studies have examined the feasibility of biology laboratory facilities and infrastructure in public school settings. A study conducted by Adilah et al. at the biology laboratory of MA Al-Ikhwan, based on observation sheets, categorized the laboratory as highly complete, with an overall average percentage of 80.75% [19]. Another study by Kasman and Ermin [20] compared laboratory management at SMAN 1 Halmahera Selatan and SMAN 12 Tidore Kepulauan. The evaluated aspects included planning, organization, administration, safety, and dynamics. The results showed significant differences in laboratory management quality: SMAN 1 Halmahera Selatan was rated as excellent in various aspects with a score of 100%, while SMAN 12 Tidore Kepulauan only excelled in the organization aspect (87%) and was rated as poor (<40%) in the other aspects. A similar study by Jamaluddin et al. [21] assessed the availability of laboratory facilities and infrastructure at SMA 6 Wajo, which achieved a 100% compliance rate based on the standards outlined in Ministry of Education and Culture Regulation No. 24 of 2007.

These findings highlight the importance of conducting comprehensive evaluations of laboratory management. However, similar studies within the context of pesantren education remain very limited. In fact, the pesantren education system has unique characteristics, such as dormitory-based learning models, the presence of musyrif

(student mentors), and intensive daily schedules, all of which can influence laboratory governance. Therefore, this study aims to evaluate the facilities and management of the biology laboratory at Pondok Pesantren Darunnajah, South Jakarta.

2. Materials and Methods

This research was conducted at Pondok Pesantren Darunnajah in November 2024. A descriptive method was employed, with the research subjects involving biology teachers. The descriptive approach was chosen to portray and explain data based on actual field conditions, particularly regarding the completeness of laboratory facilities and the extent to which laboratory activities are implemented to support the improvement of students' competencies.

Data were collected through observation, interviews, and documentation. The data collection instruments included an interview guide with questions such as, "Are the laboratory tools complete in terms of both administration and functionality?" and an observation sheet assessing "How complete is the administrative process for borrowing laboratory equipment?", both of which were developed based on current educational research standards. The observations focused on laboratory tools and practical materials, while interviews and documentation were used to gather qualitative data on the implementation of laboratory activities. The data analysis technique employed was qualitative descriptive analysis. Qualitative data obtained from interviews and documentation were used to describe the processes and challenges in conducting laboratory activities.

Through this method, the study is expected to provide a clear and accurate depiction of the laboratory conditions and the implementation of practical activities at Pondok Pesantren Darunnajah, serving as a foundation for improving the quality of biology education.

3. Results

To assess the availability and feasibility of laboratory facilities and infrastructure, an observation was conducted focusing on key components required for biology practical learning. The observation aimed to determine whether the laboratory at Pondok Pesantren Darunnajah met the minimum standards outlined in national education guidelines. The following table presents the condition of various laboratory facilities and infrastructure based on direct field observation.

Table 1. Data on the Completeness of Facilities and Infrastructure in the Biology Laboratory at Darunnajah Islamic Boarding School

No.	Facilities and Infrastructure	Condition
1	Chairs	Adequate
2	Practical work tables	Adequate
3	Laboratory staff table	Adequate
4	Equipment cabinet	Adequate
5	Document cabinet	Adequate
6	Whiteboard	Adequate
7	Bulletin board	Adequate
8	Smart board	Adequate
9	Projector	Adequate
10	CCTV	Adequate
11	First aid kit	Adequate
12	Wall clock	Adequate
13	Computer	Adequate
14	Sink	Adequate

No.	Facilities and Infrastructure	Condition
15	Air conditioner	Adequate
16	Electrical outlets	Adequate
17	Lights	Adequate
18	Additional computer	Adequate
19	Equipment table	Adequate

To gain a deeper understanding of laboratory management practices and implementation at Pondok Pesantren Darunnajah, interviews were conducted with the biology teacher and the laboratory technician. These interviews aimed to explore various aspects such as evaluation routines, borrowing procedures, equipment maintenance, staffing structure, budgeting, and practicum scheduling. The responses provide valuable qualitative insights into how the laboratory operates on a daily basis and how its management aligns with institutional policies and student learning needs. The detailed interview results are presented in table 2.

Table 2. Interview Results with Biology Teacher and Laboratory Technician at Pondok Pesantren Darunnajah

No.	Question	Answer
1	Is there any regular evaluation activity in the lab? How often—weekly, monthly, or otherwise?	Yes, evaluations are always conducted. Usually once a week, especially if a practicum does not go well. In this biology lab, there are daily practicum schedules, so evaluations are ongoing.
2	Are students allowed to borrow laboratory equipment?	Yes, they are. As long as there is an official borrowing letter approved by their supervisor or the principal.
3	Is there a time limit for borrowing equipment?	No fixed limit, but the borrowing letter specifies the borrowing period. The important thing is that the equipment is returned in good condition. If any damage occurs, the borrower is required to replace it. The procedure follows the SOP, which involves approval from the principal.
4	When is equipment maintenance or inspection carried out?	Regularly, usually after use. For example, if a microscope needs fixing, we repair it ourselves if possible. If it requires a technician, we submit a budget request first.
5	Is equipment checked before use?	Yes, always. It would be dangerous not to check it beforehand.
6	Are you the only staff managing the biology lab, or are there others?	There are others. There are four labs in total: mathematics, physics, chemistry, and biology. I serve as the head of the laboratory. Below me is a lab coordinator or person-in-charge. Each lab has one person-in-charge and supporting staff.
7	Who handles the funding requests for lab needs?	Budget requests are submitted every semester based on practicum materials for that period. I prepare the request, get it approved by the principal, then submit it using an SPMU (money disbursement request form). The principal forwards it to the leadership, and after their approval, the funds can be disbursed.

No.	Question	Answer
8	When is new lab equipment procured?	Every semester. However, if an item is damaged due to student negligence, the student must replace it.
9	Is there a schedule for lab activities?	Yes, there is. Each class has four practicums per semester.
10	Are students allowed to enter the lab outside scheduled practicum time?	Yes, if no one else is using the lab. The lab is used by both MTs and SMA students.

4. Discussion

Based on the data in Table 1, the biology laboratory facilities at Pondok Pesantren Darunnajah are considered relatively complete. The available facilities include basic equipment such as chairs, practical work tables, and storage cabinets, as well as modern supporting devices like computers, projectors, and CCTV. When compared to the minimum laboratory standards outlined in Ministry of National Education Regulation No. 24 of 2007, the laboratory meets most of the required facility and infrastructure indicators. The presence of a first aid kit and sink also indicates that safety aspects have been taken into consideration. This aligns with the findings of Mendez [22], who identified that a conducive science laboratory learning environment includes safety features to enhance students' laboratory safety practices and ensure proper handling of experiments. However, an evaluation of the functionality of technology-based facilities such as smart boards and projectors is necessary to ensure their effective use in the learning process. Lestari and Malik [23] emphasized the importance of integrating digital technologies in laboratory learning to align with curriculum adaptations and support effective teaching.

Based on interviews with the biology teacher and laboratory technician at Pondok Pesantren Darunnajah, it was found that laboratory management has been implemented systematically. Laboratory evaluations are conducted regularly (either weekly or daily) depending on the needs and practicum schedule. Students are allowed to borrow laboratory equipment following a clear procedure, which requires a borrowing letter approved by a supervisor or the school principal. Borrowed equipment must be returned in good condition, and any damage must be compensated by the borrower. This aligns with the findings of Yasra et al. [24], who emphasized that the implementation of an information system aims to ensure accountability and traceability of borrowed equipment, thus requiring all tools to be returned in proper condition.

Equipment maintenance and inspection are carried out regularly, both after use and before practical sessions begin, to ensure the safety and functionality of the tools. Compared to practices in other schools that often lack clear standard operating procedures (SOPs), this system reflects accountable and efficient laboratory management. This approach is consistent with the findings of Susanti et al. [25], who stated that proper systems for borrowing and maintaining laboratory equipment can enhance accountability in maintenance and safety, thereby ensuring the effectiveness of laboratory SOP implementation.

Laboratory management at Pondok Pesantren Darunnajah involves a well-defined organizational structure, consisting of a head of laboratory, laboratory coordinators, and staff members assigned to each laboratory. This structure ensures clarity in the execution of tasks and responsibilities and facilitates decision-making related to equipment procurement and laboratory activity implementation. A proper organizational structure is essential, as laboratory managers or staff are responsible for the effectiveness and efficiency of laboratory operations, including facilities, tools, and practical materials [26]. Compared to schools where a single teacher is solely responsible for the laboratory, this structure deserves recognition for supporting more structured and collaborative

laboratory management. Harianto [27] emphasized that participatory management fosters a collaborative school culture, which is vital for effective and organized laboratory governance.

In addition, budget proposals for laboratory needs are submitted each semester through a formal procedure involving the school principal and institution leaders. Practicum activities are conducted according to a predetermined schedule, with each class having four sessions per semester. However, students are also allowed to use the laboratory outside of scheduled times as long as it is not in use. While this frequency is higher than that of some schools—where practicums may only occur once or twice per semester—it still falls short of the ideal standard recommended in the Merdeka Curriculum. On the other hand, Kiay [28] emphasized the importance of implementing experimental methods, as they significantly enhance students' science process skills, contributing to the achievement of optimal learning outcomes in science education.

Although laboratory management has been running effectively, there is still room for improvement. One notable gap is the absence of a formal training program for laboratory staff to keep pace with technological advancements and innovations in practical learning. Taofik et al. [29] emphasized the importance of providing training for laboratory personnel to enhance occupational safety and ensure effective laboratory management. This is supported by Sulistya and Mahadesi [30], who stated that the management of science laboratories also involves human resource aspects, such as staff recruitment processes, professional training and development, as well as regular performance management and evaluation.

5. Conclusions

Based on the research findings, it can be concluded that the biology laboratory facilities at Pondok Pesantren Darunnajah are relatively complete and have met most of the standards set by the Ministry of National Education Regulation No. 24 of 2007, including safety aspects and technological support. Laboratory management is carried out in a systematic and reliable manner, encompassing regular evaluations, well-organized equipment lending procedures, routine maintenance, and structured procurement and budgeting processes. The laboratory's organizational structure, consisting of a head, coordinators, and staff, enables clear and efficient task distribution. Nevertheless, the frequency of practicum sessions, currently held only four times per semester per class, is considered suboptimal and should be increased to align with the principles of active learning promoted by the Merdeka Curriculum. Future improvements should include staff training programs to keep up with technological developments and optimizing the laboratory as a space for scientific exploration beyond regular class hours. These findings underscore the significance of effective laboratory management in supporting biology learning, particularly in pesantren-based educational environments with their unique characteristics and challenges.

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