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# Effective Laboratory Management: Efforts to Improve Science Education Management in Islamic Boarding Schools

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**Abstract:** Effective laboratory management can be applied as an effort to improve science education management in secondary schools. This study aims to explore effective laboratory management as an effort to improve science education management at MA Citra Cendekia South Jakarta. The research method used was a descriptive qualitative method with a case study approach. Data were collected through direct observation, in-depth interviews with teachers and laboratory staff, and analysis of related documents. The results showed that effective laboratory management involves several important aspects, namely careful planning, procurement and maintenance of adequate laboratory equipment, and competency development of teachers and laboratory technicians. In addition, collaboration between science teachers and laboratory staff in designing and conducting experiments also contributes significantly to improving the quality of science learning. The implementation of good laboratory management at MA Citra Cendekia South Jakarta is proven to be able to increase student learning motivation, improve understanding of science concepts, and produce more interactive and contextualised learning. This study concludes that effective laboratory management is one of the key factors in improving the quality of science education in Islamic educational institutions.

**Keywords:** education management; laboratory management, learning effectiveness; science education

## Introduction

Science education has a very important role in shaping young people who are knowledgeable and competent in the fields of science and technology (Patil et al., 2023; Zhao et al., 2024). In the current era of globalisation, the ability to think critically, creatively and innovatively is a skill that must be possessed by every individual, especially students in educational institutions (Humphry & Fuller, 2023; Mattox et al., 2023). Therefore, the quality of science learning must always be improved in order to produce graduates who are competent and ready to face future challenges.

The science laboratory is one of the important components of the science learning process (Cannon et al., 2023; Yahaya et al., 2024). Through laboratory practices and experiments, students can understand science concepts more deeply and applicatively (Mickley et al., 2003). However, the effectiveness of science learning in the laboratory is highly dependent on how the laboratory is managed (Gu et al., 2021; Tang et al., 2022). Good laboratory management will ensure that lab equipment and materials are available and can be

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used optimally and that the laboratory environment is safe and conducive to learning activities (Accettone, 2022; Anwar et al., 2023; Ferine et al., 2023).

MA Citra Cendekia (MACC) South Jakarta, as one of the Islamic educational institutions, realises the importance of effective science laboratory management in improving the quality of science education (Flaherty, 2022; Sadr et al., 2022; Saefudin, 2024; Setiawan et al., 2024). However, like many other schools, MA Citra Cendekia South Jakarta also faces various challenges in managing its laboratory, ranging from human resources to budget.

Previous research on the management of science education laboratories has been of interest to educational scholars and practitioners over the past few decades (Blumling et al., 2022; He et al., 2021; Kalogiannakis et al., 2021; Kong et al., 2022). Many studies have shown that effective laboratory management can significantly improve the quality of science learning and students' academic performance. The following is an overview of some important research relevant to this topic.

Firstly, research by Zourmpakis et al. (2022) highlighted the importance of laboratory experiences in science learning. They found that laboratory activities can improve understanding of science concepts, practical skills and positive attitudes towards science. However, they also emphasised the need for good planning and management to maximise the benefits of laboratory activities.

Furthermore, a study by Wang & Zheng (2021) examined the relationship between a well-managed laboratory environment and students' learning motivation. They found that a well-organised and well-equipped laboratory can increase students' interest and motivation in learning science. This suggests that good laboratory management affects not only the technical aspects of learning but also the psychological aspects of students.

In Indonesia, research by Murliasari et al. (2023) examined the management of science laboratories in senior high schools. The results showed that many schools still face challenges in terms of facilities and human resources. Sudibyo recommended increased training for teachers and laboratory technicians as well as an increased budget for laboratory equipment procurement as solutions to overcome these problems.

More recently, research by Riyadi et al. (2023) examined laboratory management in Islamic-based schools. They found that, in addition to the common challenges faced by other schools, Islamic-based schools also face additional challenges in terms of the integration of Islamic values in laboratory activities. This research emphasises the importance of a holistic approach that not only focuses on the technical but also the moral and spiritual aspects of laboratory management.

This research will continue and expand on previous findings with a specific focus on the science laboratory at MA Citra Cendekia South Jakarta. Using a case study approach, this research will explore effective laboratory management strategies that can be applied in an Islamic education environment in depth. It is expected that this research can make a significant contribution to the development of a laboratory management model that suits the needs and characteristics of Islamic educational institutions.

Thus, this study aims to explore and identify effective laboratory management strategies implemented at MA Citra Cendekia South Jakarta. Thus, it is expected that practical solutions can be found to overcome the existing challenges and improve the quality of science learning in the school. The focus of this research includes laboratory management planning, procurement and maintenance of laboratory equipment, and competency development of teachers and laboratory technicians. In addition, this study also explores how collaboration between teachers and laboratory staff can improve the effectiveness of science learning.

The results of this study are expected to make a meaningful contribution to the development of better laboratory management strategies, not only for MA Citra Cendekia South Jakarta but also for other educational institutions facing similar challenges.

## Method

This research used a descriptive qualitative approach with a case study method to explore effective laboratory management in improving science education management at MA Citra Cendekia South Jakarta (Yin, 2016). This approach was chosen because it allows researchers to gain an in-depth understanding of the context and phenomena being studied (Denzin & Lincoln, 2018). The following is a figure of the research flow.

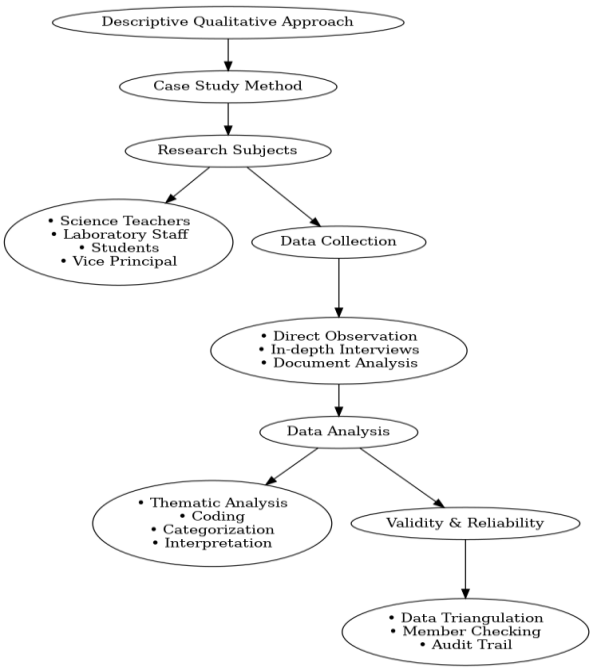


**Figure 2**. The research flow

*Research Subjects*

The subjects of this study include science teachers, laboratory staff, students, and the vice principal for facilities and infrastructure at MA Citra Cendekia located in Jagakarsa District, South Jakarta City, Special Region of Jakarta. South. The selection of subjects was carried out by purposive sampling to ensure the participation of individuals who have knowledge and experience relevant to laboratory management (Julmi, 2020).

*Data Collection*

Data were collected through the following techniques. First, direct observations were made in the science laboratory to observe the condition of the facilities, equipment, and practicum activities taking place. Observations also included interactions between teachers, laboratory staff, and students. Second, in-depth interviews with science teachers, laboratory staff, and school facilities and infrastructure were conducted using semi-structured methods to obtain information regarding laboratory management practices, challenges faced, and strategies implemented. Interviews with students were also conducted to understand their experiences and perceptions of practical activities in the laboratory. Third, document analysis was conducted on related documents such as lesson plans, practicum schedules, laboratory activity reports, and school policies to obtain additional information on laboratory management.

*Data Analysis*

The data obtained were analysed using thematic analysis techniques (Denzin & Lincoln, 2018). The analysis process included several stages. First, coding was done by organising and coding data from observations, interviews, and document analysis based on emerging themes. Second, the coded data was then categorised by grouping similar codes into broader categories to identify patterns and relationships between themes. Finally, interpretation was made by interpreting the categorised data to understand how effective laboratory management can improve science education management at MA Citra Cendekia South Jakarta.

To ensure the validity and reliability of the research, several steps were taken. Firstly, data triangulation was conducted using various data sources (observation, interviews, and documents) to confirm the findings. Second, member checking was conducted by requesting feedback from research participants to ensure the researcher's interpretations were in line with their experiences and views. Third, the audit trail was conducted by recording in detail the entire research process to ensure transparency and reproducibility of the research by other researchers (Miles et al., 2014).

This study also paid attention to ethical aspects by obtaining permission from the school and obtaining informants' consent before data collection. The confidentiality of participants' identities was maintained, and the data collected was used only for research purposes.

## Result and Discussion

Madrasah Aliyah Citra Cendekia (MACC) is a Madrasah Aliyah under the management of Yayasan Dakwah Islamiyah Ashabul Kahfi, which was established in 2008. Yayasan Dakwah Islamiyah Ashabul Kahfi is a social institution that has been active in the field of education, social, and community since 2004, under the leadership of Haji Abdul Chair, a Betawi-born bureaucrat and education activist who has dedicated his life to Madrasah education. MACC is one of the waqf foundations in the field of education that focuses on fostering Indonesia's young generation to become Muslim scholars who have Diniyah, Ilmiah, and Insaniyah integrity. These three competencies are the main focus in developing students' knowledge and character so that they can contribute positively to society. Dakwah Islamiyah Ashabul Kahfi Foundation is committed to supporting the development of an education system that is based on moderate Islamic values, human values, and nationality. To achieve this goal, the foundation has key programs such as developing the competence of teachers and employees, improving educational infrastructure, implementing a

curriculum that integrates the three main pillars (Diniyah, Ilmiah, and Insaniyah), and organisational management that is adaptive to the times. These programmes have been an integral part of the efforts to strengthen the capacity of Madrasah Aliyah Citra Cendekia since its establishment until the future. One of the existing facilities is a complete science education laboratory, including biology, physics and chemistry laboratories. From the research results, the management of science education laboratories is described as follows.

*Careful planning*

Careful planning in science laboratory management is essential to ensure effectiveness and efficiency in the learning process. This involves science teachers and laboratory staff in formulating a more structured learning plan. A well-thought-out lesson plan includes the selection of experiments that are in line with the curriculum and students' needs. Science teachers need to consider the learning objectives to be achieved, the subject matter to be delivered, and effective learning methods. In addition, the selection of experiments also needs to pay attention to student safety and the availability of the necessary equipment and materials. With careful planning, it is expected that practical activities in the laboratory can run more smoothly, and students can gain a better understanding of the science concepts taught.

*Procurement and Maintenance of Equipment*

Procurement and maintenance of laboratory equipment is an important aspect of science laboratory management. Although the laboratory has been equipped with most of the necessary equipment, routine maintenance is still needed to keep the equipment in good condition. Routine maintenance includes cleaning, calibration, and repair if needed. In addition, procurement of additional equipment is also important to ensure the sustainability of practical activities. This can be done by evaluating the equipment needs based on the curriculum used and the development of science and technology. Procurement of additional equipment can also be done to expand the variety of experiments that can be carried out by students, thus improving their practicum experience. Thus, good procurement and maintenance of laboratory equipment will support the implementation of effective and enjoyable practicum activities for students.

*Competency development of teachers and staff*

The competency development of teachers and laboratory staff is a key factor in improving the quality of laboratory science management. Training and workshops related to laboratory management need to be increased to improve the understanding and skills of science teachers and laboratory staff in designing and implementing effective practicum. Training can cover various aspects, such as active learning, the use of technology in science learning, laboratory management, and laboratory safety and security. Workshops can also be a means for teachers and laboratory staff to share experiences and good practices in laboratory management. By increasing the competence of science teachers and laboratory staff, it is expected that they can provide more interesting and interactive learning for students and can manage the laboratory more efficiently. As a result, students' learning experiences in laboratory practicum can be improved, which in turn will have a positive impact on their understanding of science concepts and the practical skills required.

*Collaboration between science teachers and staff*

Collaboration between science teachers and laboratory staff is a key element in improving the effectiveness of science laboratory management. Science teachers need to be more involved in practicum planning and laboratory use. They can work together with the laboratory staff to design practical activities that are in line with the curriculum and students' needs. Science teachers can also provide guidance on learning objectives to be achieved, learning materials to be delivered, and evaluation of practicum results. On the other hand, laboratory staff can provide the necessary technical support, such as preparing lab equipment and materials, assisting in lab implementation, and ensuring safety and security during the lab.

**Figure 2**. Science Laboratory at MA Citra Cendana

In addition, collaboration between science teachers and laboratory staff can also include the exchange of knowledge and experience. Science teachers can gain information on the latest laboratory technology developments and how to use them effectively, while laboratory staff can gain a better understanding of student learning needs and how to better support practical activities. With good collaboration between science teachers and laboratory staff, it is expected that laboratory management can become more efficient and effective, thus making a positive contribution to students' science learning.

*Application of Islamic values in laboratory activities*

The application of Islamic values in laboratory activities is an important aspect that can enrich students' learning experience. Awareness of the importance of integrating Islamic values in laboratory activities is reflected in the selection of practicum materials that are relevant to Islamic teachings. Science teachers can choose experiments or labs that not only teach science concepts but also reflect moral and spiritual values in Islam, such as honesty, cooperation, and care for the environment.

In addition, the laboratory environment can also be created in such a way that it reflects Islamic values, for example, by creating a calm and clean atmosphere, paying attention to safety and health in every practicum, and encouraging mutual respect and appreciation between students and teachers. This will help students understand that Islamic values are relevant not only in everyday life but can also be applied in the context of science and technology.

Thus, the application of Islamic values in laboratory activities not only contributes positively to the formation of students' noble character but can also improve their understanding of the science concepts taught. Thus, the application of Islamic values in laboratory activities can be an integral part of efforts to improve the quality of science education at Madrasah Aliyah Citra Cendekia.

Effective laboratory management is very important in improving science education management at Madrasah Aliyah Citra Cendekia (MACC). The research results include several important findings that can be the basis for further discussion. Firstly, careful planning is the key to laboratory management. Science teachers and laboratory staff need to formulate well-structured lesson plans, including the selection of experiments that suit the curriculum and students' needs (Hu-Au & Okita, 2021; Sun et al., 2022). With careful planning, it is expected that practicum activities can run more efficiently and effectively.

Second, the procurement and maintenance of laboratory equipment also has a very important role. Although the laboratory has been equipped with most of the necessary equipment, routine maintenance and procurement of additional equipment are still needed to ensure the sustainability of practicum activities (Ozkan & Umdu Topsakal, 2021; Zhai et al., 2022). Good equipment maintenance will also help in preventing damage and extending the life of the equipment.

Furthermore, developing the competence of teachers and laboratory staff is also important in laboratory management. Training and workshops related to laboratory management need to be increased to improve their understanding and skills in designing and implementing effective practicum (Saw & Agger, 2021; Turan & Atila, 2021; Sjahruddin et al, 2024). With increased competence, it is expected that the quality of learning in the laboratory will also improve.

Collaboration between science teachers and laboratory staff is also needed to improve the effectiveness of laboratory management. Science teachers need to be more involved in practicum planning and laboratory use, while laboratory staff can provide the necessary technical support (Almasri, 2022; Nguyen & Dang, 2021). With good collaboration, it is expected that laboratory management can run more smoothly and efficiently.

Finally, the application of Islamic values in laboratory activities is also an important thing to note (Saefudin et al., 2023; Prasetyo & Saefudin, 2023). This can be done by selecting practicum materials that are relevant to Islamic teachings and creating a laboratory environment that reflects Islamic moral and spiritual values (Riyadi et al., 2023; Saefudin et al., 2024; Sulistianingsih et al., 2022). Thus, it is expected that practicum activities will not only provide scientific knowledge but also shape the character of students with noble character.

Overall, effective laboratory management at MACC requires integrated efforts from various parties, including science teachers, laboratory staff, and school management. With the implementation of all the aspects discussed above, it is expected that laboratory management at MACC can make a great contribution to improving the quality of science education and shaping the character of quality students.

Overall, effective laboratory management at MACC requires integrated efforts from various parties, including science teachers, laboratory staff, and school management. This research shows that good collaboration and communication among all these parties are key to creating a laboratory environment that is conducive to learning. The main implication of this study is the improvement of the quality of science education through optimal use of facilities and better integration of the curriculum, allowing students to gain rich and in-depth practical experience. In addition, good laboratory management can encourage students'

character development through project-based learning and strict implementation of laboratory safety and ethical standards, which teach discipline and responsibility. The efficiency and professionalism of laboratory staff are also improved by proper training and development, as well as close collaboration with science teachers. On the other hand, school management that is proactive in investing in facilities, establishing clear policies and procedures, and providing professional support will ensure efficient and safe laboratory operations. With the implementation of all these aspects, it is expected that laboratory management at MACC can make a significant contribution to improving the quality of science education and building a high student character. This research also encourages the importance of continuous evaluation and adaptation of laboratory management strategies to ensure sustainability and relevance to the development of science and technology.

## Conclusion

This study highlights that effective laboratory management plays a crucial role in enhancing science education management at Madrasah Aliyah Citra Cendekia (MACC). Key factors contributing to this improvement include careful lesson planning aligned with the curriculum, regular maintenance and procurement of laboratory equipment, and the development of teacher and staff competencies through training. Moreover, collaboration between science teachers and laboratory staff is vital in planning and executing practical activities, ensuring technical support, and integrating Islamic values into the educational process. This collaborative approach not only elevates the quality of science education at MACC but also fosters the development of students' character, reflecting Islamic moral and spiritual values.

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**Conflicts of Interest**
The authors declare no conflict of interest.

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