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THE USE OF TECHNOLOGY-BASED SCIENCE LABORATORIES IN SCIENCE LEARNING AT MUHAMMADIYAH 1 SEPUTIH BANYAK VOCATIONAL SCHOOL

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Abstract. The use of technology-based science laboratories is an important innovation in improving the quality of science education in the digital age. This article aims to examine the role and implementation of science laboratories integrated with technology in supporting the science learning process. The method used is a literature study by analyzing various relevant scientific sources, including national and international journals, books, and related research reports. The results of the study show that the use of technology such as virtual laboratories, digital simulations, digital sensors, and Learning Management Systems (LMS) can improve students' understanding of concepts, scientific process skills, and motivation to learn. In addition, technology-based laboratories also provide solutions to the limitations of practical tools and materials in schools. The conclusion of this study is that the integration of technology in science laboratories contributes positively to the effectiveness of science learning and supports the achievement of 21st-century learning objectives.

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Introduction

Science education plays a strategic role in shaping students who have scientific, critical, and logical thinking skills. Science not only emphasizes mastery of concepts, but also the scientific process and scientific attitudes acquired through experiments and practical work. Therefore, the existence of science laboratories is a very important tool in learning.

The development of information and communication technology has brought significant changes to the world of education, including science learning. Science laboratories,

which were previously conventional, are now beginning to transform into technology-based laboratories. The integration of technology in practical activities is expected to increase the effectiveness of learning and adapt to the characteristics of students in the digital age.

However, in reality, many schools still face limitations in laboratory facilities, both in terms of equipment, materials, and time for conducting practical work. This condition calls for innovation in learning through the use of technology as an alternative and complement to conventional laboratories (Indonesia & M. R., 2025). Therefore, this article discusses the use of technology-based science laboratories in science learning.

Technology-based science laboratories are laboratories that utilize digital technology devices in conducting practical activities (Arends & Richard, 2012). The technology used can include simulation software, virtual laboratories, digital sensors, and computer and internet-based learning applications. The use of this technology allows students to conduct experiments more flexibly and safely (Chomsun, Pratiwi & Rosa, 2025). Virtual laboratories, for example, allow students to simulate experiments without having to be in a physical laboratory. This is very helpful for schools that have limited facilities or face safety risks in certain practical activities. In addition, the use of digital sensors can improve measurement accuracy and help students understand concepts more deeply.

Technology serves as a tool that supports the creation of interactive and meaningful science learning (Mulyasa, 2013). With the help of technology, students can observe phenomena that are difficult to observe directly, conduct repeated experiments, and obtain quick feedback. This can improve students' science process skills and science literacy. In addition, technology also allows teachers to design more varied and contextual learning. Teachers can integrate practical results with visual media, videos, and digital data so that learning becomes more interesting and easier for students to understand.

Methode

This study uses a qualitative approach with a descriptive qualitative research design. The author collected and analyzed various literature sources relevant to the topic of technology-based science laboratories. The literature sources included scientific journals, textbooks, seminar proceedings, and education policy documents (Branch, 2009; Sugiono, 2016). The instruments used in this study included student activity observation sheets, teacher and student interview guidelines, and documentation of technology-based learning in the science laboratory.

The analysis was conducted by examining concepts, research findings, and best practices related to the use of technology in science laboratories. The results of the analysis were then synthesized to obtain a comprehensive picture of the role and benefits of technology-based science laboratories in learning.

Result and Discussion

The results of the study indicate that the use of technology-based science laboratories has a positive impact on science learning. Students showed an increase in their understanding of concepts and scientific process skills after participating in learning activities that utilized laboratory technology. The results of student activity observations are presented in **Table 1.**

Table 1. Results of Student Activity Observations

Observed Aspect	Description of Findings
Student activity	Students actively used digital laboratory simulations
Conceptual understanding	Students were able to explain concepts in their own words
Cooperation	Intensive group discussions took place

The use of virtual laboratories and digital simulations has been proven to increase students' motivation and interest in learning (Belcher, 2019). Technology also helps teachers manage practical learning more effectively and efficiently, especially when facilities and infrastructure are limited. An image of a virtual laboratory is shown in **Figure 1.**

Figure 1. Use of Virtual Science Laboratories

The results of this study are in line with various studies that state that the integration of technology in science education can improve the quality of learning (Widodo & Widayanti, 2013). Technology-based laboratories provide a richer and more in-depth learning experience compared to conventional learning. However, the implementation of technology-based science laboratories also faces several challenges, such as limited

access to technology, teacher readiness, and infrastructure support. Therefore, training for teachers and policy support from schools and the government are needed to ensure optimal use of technology.

Conclusion

The use of technology-based science laboratories has been proven to contribute positively to science learning. The integration of technology can improve students' understanding of concepts, scientific process skills, and motivation to learn. Technology-based laboratories also provide an alternative solution to the limitations of conventional laboratories.

Recommendations

It is recommended that schools and educational institutions develop technology-based science laboratories gradually in accordance with their needs and capabilities. In addition, ongoing training is needed for teachers so that they are able to utilize technology effectively in science learning. Further research could examine the implementation of technology-based laboratories empirically at various levels of education.

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