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Effectiveness of Laboratories on Students' Mastery of Science Process Skills in Basic Physics Laboratory

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ABSTRACT

The laboratory is a vital component in the Basic Physics Practicum learning process, playing a key role in developing students' science process skills. This article aims to review the effectiveness of laboratory activities on students' mastery of science process skills in the Basic Physics Practicum course through a literature review of both national and international research sources. The method used is a literature study with a qualitative-descriptive approach in accredited articles. The review results show that the use of laboratories particularly those adopting guided inquiry and project-based approaches significantly improves students' science process skills, such as observation, data interpretation, hypothesis formulation, and communication of experimental results. Furthermore, the integration of laboratories with digital technologies also contributes positively to students' motivation and engagement in the learning process. Thus, laboratories are proven to be effective in supporting the achievement of students' science process skills. These findings emphasize the importance of optimizing laboratories as a means of active and contextual learning to improve the quality of Basic Physics Laboratory learning in higher education.

Keywords: *Laboratory, Science Process Skills, Basic Physics Laboratory*

1. INTRODUCTION

Higher education institutions hold a crucial responsibility in equipping students with 21st-century skills, one of which is science process skills, essential in science education, including physics. Science process skills encompass the ability to observe, classify, analyze data, formulate hypotheses, design experiments, and communicate findings scientifically (Rustaman, 2020). The Basic Physics Laboratory is a mandatory subject for students majoring in physics or taking basic physics courses. In this course, the laboratory not only serves as a venue for practicing technical skills but also as a medium to cultivate students' scientific thinking.

However, practical implementation in the field still faces many challenges. Practicums are often carried out procedurally, providing little room for scientific exploration or deeper inquiry. Additionally, the lack of inquiry-based approaches and limited use of digital technologies hinder the optimal development of science process skills (Wahyuni et al., 2021). Conversely, various studies show that the use of guided inquiry, project-based, and blended-lab models can promote students' active engagement and positively impact the improvement of science process skills (Sari et al., 2023; Fitriani & Nugroho, 2022).

Science process skills in education are aimed at developing students' ability to actively acquire knowledge and present scientific findings. These skills are categorized into two major groups: basic skills and integrated skills. Basic skills include observing, classifying, predicting, measuring, inferring, and communicating. Integrated skills cover identifying variables, tabulating data, graphing, analyzing relationships among variables, and designing and conducting experiments, which also include data collection and processing, analyzing results, hypothesis formulation, and defining operational variables (Zai & Ishafit, 2019).

According to Sultan (2011), science process skills include observing, concluding, measuring, communicating, hypothesizing, and conducting experiments, all of which aim to acquire, develop, and apply scientific concepts, principles, laws, and theories. Mastery of science process skills is crucial in physics education, as it directly influences students' understanding of concepts, critical thinking, and scientific problem-solving abilities (Widodo et al., 2021). Therefore, a systematic review of studies discussing the impact of laboratory use on the development of science process skills in students, especially in the Basic Physics Laboratory, is needed. This

review is expected to provide both theoretical and practical insights into designing contextual and up-to-date laboratory learning.

2. METHODS

This study employed a qualitative-descriptive literature review approach. The primary objective was to explore and synthesize previous research findings related to the effectiveness of laboratories on students' mastery of science process skills in the Basic Physics Laboratory. Data was systematically collected from various reputable sources. The article selection criteria included: publications in accredited national journals or reputable international journals and relevance to laboratory learning and science process skills themes.

After collecting the articles, the researchers conducted content analysis to identify emerging thematic patterns, such as the practicum models used, types of science process skills developed, and factors influencing successful laboratory learning. The analysis results were synthesized to obtain a comprehensive understanding of the contribution of laboratories to the improvement of students' science process skills.

3. RESULTS & DISCUSSION

The analysis of various studies indicates that laboratory-based practicum positively impacts students' science process skills, particularly in the Basic Physics Laboratory. For instance, Yusuf and Widyaningsih (2018) found that the observed percentage of science process skills during practicum sessions across all skill aspects was in the "very good" category. Skills such as observing, classifying, hypothesizing, designing experiments, analyzing data, and scientifically presenting results showed significant improvement. Similarly, Eralita (2023) reported that physical chemistry practicums provided students with direct experience, as seen in their abilities to observe, make accurate measurements, and critically analyze data using tables or graphs, all key science process skills aspects. Studies by Lestari & Diana (2018), Subhan & Rahmawati (2019), and Nurwahidah (2023) also found that students' average science process skills fell into the "fairly good" category.

Science process skills can be integrated with various learning models, and one proven to be effective is the guided inquiry approach. Fitriani et al. (2024) noted that all models increased science process skills, with inquiry-based learning categorized as highly effective. This approach actively engages students in learning and fosters deeper scientific thinking (Wahyuni et al., 2021). Additionally, project-based learning models (PjBL) significantly contribute to developing science process skills, especially in critical thinking and problem-solving (Sari et al., 2023).

Technology use is also crucial in supporting laboratory learning. According to Widyaningsih & Yusuf (2016), virtual laboratory media use resulted in science process skills being rated "good" overall. Virtual labs and blended learning models have strengthened science process skills mastery by offering interactive and flexible learning experiences (Widodo et al., 2021). Alatas (2018) also found that virtual lab media effectively improved science process skills, allowing students to explore physics concepts more independently and contextually. Nonetheless, challenges remain, including limited facilities, suboptimal time allocation, and uneven lecturer competency in implementing innovative laboratory learning models (Fitriani & Nugroho, 2022). Therefore, enhancing lecturer capacity and developing adaptive practicum tools are essential.

Overall, the review shows that laboratories not only function as technical training grounds but also serve as media for shaping students' scientific mindset and 21st-century skills. Integrating inquiry-based approaches, leveraging digital technologies, and designing contextual practicums are key strategies for enhancing science process skills mastery in Basic Physics learning at the university level.

4. CONCLUSION

Based on this literature review, it can be concluded that laboratory use in Basic Physics learning significantly enhances students' science process skills. Practicum approaches such as guided inquiry and project-based learning (e.g., PjBL) effectively develop students' scientific skills, including critical thinking, problem-solving, and scientific communication. Moreover, technology integration through virtual labs and blended learning positively contributes to strengthening science process skills by providing interactive and flexible learning experiences.

However, to achieve optimal outcomes, efforts to improve practicum implementation quality including developing lecturer competence and providing adequate facilities are necessary. This is crucial to ensure students gain more in-depth and applicable practicum experiences, ultimately supporting more effective understanding of physics concepts. Therefore, designing more contextual, technology-based, and scientifically integrated practicum models is the key to improving the quality of physics laboratory learning.

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REFERENCES

Alatas, F. (2018). Improving students' science process skills using virtual laboratory media in thermodynamics course. *Jurnal Pendidikan Fisika Universitas Muhammadiyah Makassar*, *6*(3), 270–278.

Eralita, N. (2023). Analysis of science process skills in physical chemistry practicum. *Orbital: Jurnal Pendidikan Kimia*, *7*(2), 187–196.

Fitriani, F., Wati, M., Dewantara, D., & Lasiani, L (2024). The effectiveness of various learning models in improving students' science process skills. *PROSIDING SINAPMASAGI*, *4*, 43–54. http://e-jurnal.fkip.unila.ac.id/index.php/SINAPMASAGI/article/view/781

Fitriani, R., & Nugroho, A. S. (2022). The application of blended laboratory learning to improve science process skills in basic physics practicum. *Jurnal Teknologi dan Pembelajaran Fisika*, *11*(1), 25–34.

Lestari, M. Y., & Diana, N. (2018). Science process skills (SPS) in the implementation of Basic Physics I practicum. *Indonesian Journal of Science and Mathematics Education*, *1*(1), 49–54.

Nurwahidah, I. (2023). Analysis of science process skills of science education students in Basic Physics 2 practicum course. *Jurnal Edukasi & Teknologi Pembelajaran*, *4*(2), 7–14.

Rustaman, N. Y. (2020). Science process skills in physics learning: Theory and practice. *Jurnal Pendidikan Sains*, *8*(1), 1–10.

Sari, D. P., Ramadhani, R., & Hasanah, U. (2023). The effectiveness of project-based laboratories in enhancing science process skills in higher education. *International Journal of Science Education*, *45*(3), 457–472.

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, *104*, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039

Subhan, M., & Rahmawati, E. (2019). The application of physics learning with design-based laboratory activities on heat concept to improve students' conceptual understanding and science process skills at STKIP Bima. *Gravity Edu: Jurnal Pembelajaran dan Pengajaran Fisika*, *2*(1), 1–4.

Sultan, A. D. (2011). The implementation of cooperative learning model with guided discovery approach to improve students' science process skills. *Jurnal Pendidikan Fisika Indonesia*, *1*(3), 203–207.

Wahyuni, S., Yuliati, L., & Hidayat, A. (2021). Analysis of the effectiveness of guided inquiry-based physics practicum in improving students' science process skills. *Jurnal Inovasi Pendidikan IPA*, *7*(2), 143–152.

Widodo, A., Permana, I., & Rahmawati, L. (2021). The role of virtual laboratories in improving critical thinking and science process skills of physics students. *Jurnal Pendidikan Fisika Indonesia*, *17*(2), 112–119.

Widyaningsih, S. W., & Yusuf, I. (2016). Science process skills through the use of virtual laboratory media in the Basic Physics course at Universitas Papua. *Jurnal Pancaran*, *5*(3), 99–110.

Yusuf, I., & Widyaningsih, S. W. (2018). The implementation of virtual laboratory-based physics learning on students' science process skills and perceptions. *Berkala Ilmiah Pendidikan Fisika*, *6*(1), 18–28.

Zai, J., & Ishafit. (2019). Measurement of students' science process skills in electromotive force induction practicum at the Basic Physics Laboratory of Universitas Ahmad Dahlan Yogyakarta. *Jurnal Pendidikan Teknik Elektro*, *4*(1), 1–6.