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LACK OF SCHOOL LABORATORY FACILITIES LEADS TO SCIENCE LEARNING DILEMMAS: WHY PHET SIMULATIONS ARE NOT ENOUGH

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Abstract. Natural Sciences Learning requires the active involvement of students through scientific activities such as practicums, to develop an understanding of the concepts and skills of the scientific process. However, limited laboratory facilities are a major problem in many schools. This article aims to examine the challenges of implementing Natural Sciences learning at the junior high school level with the limitations of laboratories and their implications for students' science process skills. This study uses a descriptive qualitative approach with limited literature review methods and field studies through semi-structured interviews with natural science teachers in three junior high schools in Sidomulyo, South Lampung. The results of the study showed that two schools did not have natural science laboratories so practicum activities were not carried out, while one school had a laboratory but its utilization was not optimal and relied more on PhET simulations. This condition is not in line with the learning outcomes of Science Phase D in the element of process skills, especially the aspect of observation and the use of direct measuring instruments. Alternative contextual learning solutions through a combination of digital simulations and simple tool-based practicum are needed so that science learning goals can be achieved more completely.

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Introduction

Natural science (IPA) learning has a very important role in equipping students with scientific knowledge and science process skills. (Lubis et al., 2023)concludes that science has a very important role in daily life. Science learning does not only focus on concepts but also emphasizes on the scientific process and the development of students' scientific attitudes. Science can be described as a method of knowledge obtained through experimentation and experimentation. (Pinasthika & Kaltsum, 2022) stated that science learning accustomed students to conduct experiments, observation activities, collect

data and conclude a phenomenon that will be used as learning and applied in daily life. Science learning activities with experimental methods are able to increase students' understanding of concepts and improve student learning outcomes (Hurit & Wati, 2020). According to (Setiawati et al. 2021), practicum activities are often constrained by the lack of laboratory facilities as well as experimental tools and materials. Based on the research excerpts submitted, it can be shared that science learning ideally requires scientific activities that involve students directly. Experimental activities not only serve to deepen the understanding of concepts but also to develop students' science process skills. Therefore, the use of practicum activities is important in science learning.

This article was written to examine the challenges in science learning at the junior high school level, especially in the implementation of learning that requires practicum activities as an important part of learning. This article is focused on the challenges of schools with limited laboratory facilities and their implications for students' science process skills. Based on the results of interviews with science teachers in three schools in Sidomulyo Regency, South Lamnpung Regency which are the locations for science learning observations, it was found that two schools did not have science laboratory facilities, so practicum activities could not be carried out. While one other school had laboratory suggestions but was not optimal in its use, teachers were more likely to use PhEt simulation technology. The conditions of these three schools are not in line with the Science Learning Outcomes Phase D set by the Independent curriculum on the element of Process skills. This element has an observation aspect, which directs students to be able to use tools in making direct measurements and observations of observed objects.

Based on these conditions, an alternative approach is needed to ensure that science practicum activities can still be carried out even though laboratory facilities are limited. Therefore, this article explores the challenges faced by schools in implementing science practicum and examines the potential use of simple tools and material-based practicum modules. Through this discussion, this article seeks to identify how the module can serve as a viable strategy to support students' science process skills and psychomotor development in accordance with the demands of the Independent Curriculum.

Methode

This article uses a descriptive qualitative approach with limited literature review and field study methods. This approach was chosen to describe in depth the conditions of science learning, especially the implementation of practicum in schools that have limited laboratory facilities. The field study was conducted through semi-structured interviews with science teachers in three junior high schools in Sidomulyo Regency, South Lampung Regency. Interviews focused on applied science learning practices, the availability of laboratory facilities, and the use of alternative learning media such as PhEt simulations. Interview data was used to identify factual problems faced by schools in the implementation of practicum. This article is also supported by a literature review sourced from national journal articles relevant to science learning topics, practicums, science process skills, and the use of PhET simulations. The literature used was analyzed to strengthen the theoretical foundation and compare the field findings with the results of previous research.

The data analysis technique is carried out in a descriptive-analytical manner, namely by grouping field findings and the results of literature studies into main themes, such as the limitations of laboratory facilities, the use of PhET simulations, and its implications on students' science process skills. The results of the analysis are then used to formulate conclusions and recommendations related to science learning strategies that are more contextual and applicative in schools with limited facilities.

Result and Discussion

The Role of PhET Simulations in Science Learning

PhET simulation is one of the technological innovations that are widely used in science learning. The PhET helps students understand abstract concepts through interactive animations and engaging visualizations.(Lubis et al., 2023) stated that the PhET simulation is able to increase the learning effectiveness of students. The use of PhET simulations also has an impact on increasing concept understanding in science learning(Tanzillal et al., 2026). Meanwhile, in the realm of learning motivation, the use of PhET simulations also has a good influence or improvement on science learning(Rahayu & Sartika, 2020). This is a great example of the benefits of using a PhD simulation where students can know various science concepts without having to do it in real life, which requires quite complex time and means. The use of PhET is able to provide solutions to problems for schools that have problems with the lack of laboratory facilities and the use of PhET simulations can improve students' learning abilities(Fatikasari et al., 2020). However, this still leaves a note that students should be able to dig up more information about the material being discussed.

The information provides a clue that the PhET simulation has limitations because it is virtual and does not involve the student's sensory experience. On the other hand, teachers have Science Learning Outcomes in the elements of science process skills presented in Figure 1.

Procces Skills	1. **Observing** Using a variety of tools to measure and observe. Pay attention to the relevant details of the observed object. 2. **Questioning and Prediction** Students can independently ask further questions to clarify their observations and make predictions about scientific inquiry.

Figure 1. Science Learning Outcomes Stage D Skill Element Process

The use of virtual laboratories such as PhET simulations with real laboratories certainly has certain comparisons. . The use of PhET simulation platforms in science learning can improve science process skills but has limitations, especially direct practice (Rahmawati & Sulistyo, 2022). (Murni et al., 2019) mentioned that there are differences in student learning outcomes, both in cognitive and psychomotor aspects, between the use of real laboratories and real-virtual combined laboratories in science learning. Learning that utilizes a real-virtual lab combination has been shown to produce better results compared to using a real lab alone. However, this does not apply to certain materials where students must have the ability to use laboratory tools such as measuring instruments. It is

emphasized that real laboratory activities cannot be replaced by virtual laboratories because students directly hold devices that are able to train their senses and psychomotor(Quddus et al., 2017). So it can be concluded that the PhET simulation is able to help the science learning process with its virtual experiments but cannot replace the role of laboratories or experiments in real life.

Laboratory Tool Operating Skills: A Thrust-Term Case Study

Although virtual labs are able to improve understanding of concepts, the use of virtual labs can improve students' science process skills, but they cannot replace the position of real practicum.(Sholekhah et al., 2025). (Dewa et al., 2025) Confirms that the operating skills of measuring instruments such as calipers still require real practical experience. This shows that digital simulations cannot completely replace hands-on practicum-based learning. Mastery of basic measuring instruments, such as calipers, is an important competency in science learning. The use of calipers requires the skill of reading the main scales and nonius scales, understanding the concept of precision, and taking measurements with the proper position of the tool. These skills are psychomotor and require hands-on practice. This shows that laboratory equipment operation skills cannot be obtained optimally without real practicum experience.

The Dilemma of Schools Without a Science Laboratory

Schools that do not have science laboratories face a serious dilemma in achieving the learning objectives set out in the curriculum. On the one hand, science teachers are required to carry out meaningful, contextual, and oriented learning that is oriented towards developing students' science process skills. On the other hand, the limitations of laboratory facilities and infrastructure make practicum activities as the core of science learning difficult to be carried out optimally.

Based on the results of interviews with science teachers in three junior high schools in Sidomulyo District, South Lampung Regency, it was found that two schools did not have science laboratory facilities at all. This condition causes teachers not to carry out practicum directly, especially practicum that involves the use of measuring instruments and observation of real objects. Meanwhile, one other school already has laboratory facilities, but its utilization is not optimal. Teachers prefer to use PhET simulations as an alternative to practicum learning because they are considered more practical and efficient. The use of digital simulations such as PhET does provide convenience in conveying science concepts, especially in abstract materials. However, the full reliance on virtual simulations has the potential to create a gap between understanding concepts and mastering students' psychomotor skills. Students do not gain hands-on experience in using laboratory equipment, taking measurements, or handling technical problems that generally arise in real practicum.

This condition is not in line with the Science Learning Outcomes Stage D in the element of process skills, especially in the observation aspect, which emphasizes the ability of students to use various tools to make measurements and direct observations of the observed objects. Without real practicum experience, these skills are difficult to develop

optimally, even if learners have understood concepts theoretically through digital simulations. This dilemma shows that the limited laboratory facilities cannot be used as an excuse to eliminate practicum activities in science learning. (Ramadani et al., 2022) Stating that with practicum activities, students will be trained in science process skills and psychomotor skills. Alternative learning approaches that are more contextual and realistic are needed, such as the development of simple tool-based practicums, the use of the surrounding environment as a learning resource, and the application of classroom-based mini-laboratories. With this strategy, students can still gain direct scientific experience, so that the goals of science learning can be achieved more fully even in limited facilities.

Alternative Solutions for Science Learning

Science learning requires practicum activities even though it has laboratory facilities, can be carried out in the classroom and can improve the quality of learning(Vitasari & Suryani, 2022). One of the solutions that can be applied is the development of a practicum based on simple tools and used goods that are easy to get. Simple measuring instruments, such as calipers or affordable artificial measuring instruments, can be used to train students' basic skills. In addition, the application of the Project Based Learning (PjBL) learning model can encourage students to actively design and use simple tools in practicum activities. This makes students learn directly in learning. (Septianingsih et al., 2026) Explained that the PjBL learning model is effective in improving the quality of science learning at all levels and contributing to student motivation, learning outcomes and skills. Sudharsomo, et al. (2024) stated that hands-on learning or learning by doing plays an important role in developing students' critical thinking and basic skills. Real practicum activities can be carried out with the use of surrounding goods that are adjusted to the concept of science material. (Juliyeti, 2021) explained that the use of simple tools in science learning has a good role and influence in science learning. Therefore, the development of learning combined with real practicum based on simple tools that are easy to obtain can be an alternative solution.

A combination approach between PhET simulation and real practicum is also an effective solution. Simulations can be used as a pre-practicum to introduce concepts, while simple practicums are used to practice tool operation skills. Thus, science learning continues to support the mastery of concepts as well as the development of science process skills even though it is carried out in limited conditions of laboratory facilities.

Conclusion

Based on the results of the literature review and field findings, it can be concluded that science learning should ideally be carried out through scientific activities that involve students directly, especially through practicum activities. Practicum activities not only play a role in deepening the understanding of concepts, but also are very important in developing scientific process skills, especially the skills of observing, measuring, and using laboratory equipment. Field findings in three junior high schools in Sidomulyo Regency show that limited laboratory facilities are the main obstacle to the implementation of science practicum. Two schools do not have science laboratories so learning tends to be theoretical, while one school that has laboratories has not made

optimal use of them and relies more on PhET simulations. The use of PhET simulations does help students understand science concepts, but it is not able to completely replace real practicum experiences, especially in mastering psychomotor skills such as the use of long-term measuring tools. This condition shows that there is a gap between the demands of the Independent curriculum, especially the Science Learning Outcomes Phase D on the elements of process skills, and learning practices in the field. Therefore, science learning in schools with limited laboratory facilities requires a more contextual and realistic approach so that students' science process skills can continue to develop optimally.

Recommendations

Based on the results of this study, it is suggested that science learning in schools with limited laboratory facilities does not only depend on digital simulations such as PhET, but is combined with simple tool-based practicum activities and the use of the surrounding environment. Teachers need to develop creative and contextual learning strategies, such as classroom-based mini-labs or Project Based Learning (PjBL) implementations, to train students' science process skills, especially in the use of hands-on measuring tools. In addition, the support of schools and policymakers is needed in providing simple guidance and practicum facilities so that science learning achievements, especially in the element of process skills, can be achieved more optimally.

References

Dewa, E., Panis, I. C., & Kii, O. A. (2025). Physics Measuring Instrument Education with Virtual Lab Olabs and Measurement Practicum KIT for Junior High School Students. Indonesian Civil Society Journal, 4(2), 217–228. https://doi.org/10.59025/dwhwj437

Fatikasari, R., Matius, B., & M. Junus. (2020). Students' Cognitive Learning Outcomes through the Application of the Inquiry Learning Model Assisted by PhET Simulation Media Class XI Science SMA Negeri 1 Static Fluid Material. Journal of Literacy in Physics Education (JLPF), 1(01), 65–72. https://doi.org/10.30872/jlpf.v1i01.84

Hurit, A. A., & Watts, M. L. (2020). Improving Science Learning Outcomes Using Experimental Methods in Grade IV Elementary School Students. Musamus Journal of Primary Education, 2(2), 85–90. https://doi.org/10.35724/musjpe.v2i2.2455

Juliyesi, S. (2021). THE USE OF SIMPLE TEACHING AIDS TO INCREASE ATTENTION AND LEARNING ACHIEVEMENT OF SCIENCE CLASS VIII SMP NEGERI 8 PAGAR ALAM. DIADIK: Scientific Journal of Educational Technology, 11(2).

Lubis, N., Mutiara, M., Asriani, D., Sakila, R., & Saftina, S. (2023). The Importance of the Role of Science in Daily Life. ADAM Journal : Journal of Community Service, 2(1), 119–123. https://doi.org/10.37081/adam.v2i1.1380

Murni, S., Susilawati, S., & Sridana, N. (2019). The Difference in Learning Achievement in Physics Learning Using Real and Virtual Laboratories Reviewed from the Scientific Attitude of Students. Journal of Master of Science Education Service, 1(1). https://doi.org/10.29303/jpmpi.v1i1.218

Pinasthika, R. P., & Kaltsum, H. U. (2022). Basic journal. Journal of Basicedu, 6(4), 5877–5889.

Quddus, A., Hamid, T., & Kasli, E. (2017). Comparison of Physics Learning Outcomes Using Real Laboratories and Virtual Laboratories. Student Scientific Journal (JIM), 2(1), 122–127.

Rahayu, C, D & Sartika, S, B. (2020). Students Learning Motivation and Concepts Understanding of Science through the Use of PhET Interactive Simulations Motivasi Belajar dan Pemahaman Konsep IPA. Science Education Journal SEJ, 4(1), 63–76. https://doi.org/10.21070/sej.v4i1.750

Ramadani, R., Dini, I., Masri, M., Indonesia, Q. E., Hertasning, C. L., Makassar, U. N., Daeng, J., & Makassar, T. (2022). Analysis of Science Process Skills of Grade XI Science 3 SMAN 11 Makassar Students Through the Practicum Method on Acid and Base Solution Materials The Analysis Science Process Skills Student in 11. 3(April), 1–11.

Septianingsih, S., Aulia, E. V., & Mahdiannur, M. A. (2026). PENSA E-JOURNAL: SCIENCE EDUCATION THE EFFECTIVENESS OF PROJECT-BASED LEARNING IN IMPROVING LEARNING OUTCOMES. 14(1), 47–51.

Sholekhah, E. F., Febriyanto, H., & Artikel, I. (2025). Journal of Indonesian Science Tadris Development of a Virtual Lab for Substance Expansion to Improve. pp. 5(02), 220–236.

Tanzillal, M. I., Hertanti, E., & Suwarna, I. P. (2026). The Effect of PhET Interactive Simulations on Students' Conceptual Understanding of Thermodynamics Material. 14(1), 121–130.

Vitasari, M., & Suryani, D. I. (2022). Practicum-Based Science Learning Analysis at State Junior High School in Pontang District, Serang Regency. 6(2), 346–352.

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