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Comparative Analysis of Direct Instruction and Practicum-Based Learning on Students' Learning Outcomes

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ABSTRACT

Physics learning plays an important role in developing logical and analytical thinking skills, but still faces obstacles due to its abstract nature, dominant theory, and minimal experimental activities. On the other hand, the Direct Instruction model offers systematic and structured material delivery, while practicum-based learning provides more concrete empirical experiences. This study aims to compare the effectiveness of the two approaches on student learning outcomes. The method used is quantitative descriptive with a Quasi-Experimental Non-Equivalent Control Group Design. The sample was selected through a purposive sampling technique involving 16 students each in the experimental and control classes. The research instruments were a pre-test and a post-test consisting of 10 multiple-choice questions on the material of density and hydrostatic pressure. Data analysis was carried out through normality tests, N-Gain calculations, and Mann–Whitney U tests using the IBM SPSS Statistics 26 application. The results showed a significant difference, where practicum learning was more effective in improving student learning outcomes than direct learning. Therefore, practical-based learning helps students understand concepts better and involves student activities.

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INTRODUCTION

Physics learning is an important part of science education because it helps students develop logical and analytical thinking, as well as problem-solving skills. However, in practice, teaching physics in schools often faces challenges due to its abstract nature and the large number of formulas, which make the concepts difficult to understand and the learning goals hard to achieve (Daun et al., 2022; Hasibuan et al., 2022; Yuniati et al., 2023). In fact, conceptual understanding is the main foundation for students to understand physics and natural phenomena (AJ, Furqon, et al., 2025). In addition, physics teaching is often too focused on theory and lacks practical application (AJ et al., 2024; Astuti et al., 2022).

One approach that is often used in physics learning is Direct Instruction (DI). Direct Instruction is a teacher-centered approach in which the teacher has full control over the learning process (Zega et al., 2022). This model focuses on delivering material directly, systematically, and clearly through concept explanations, demonstrations, guided practice, and evaluation (Salsabiillah et al., 2025). It also gives the teacher a central role as the main facilitator, from explaining and demonstrating to giving examples, practice, and reflection (Boxer, 2020). Therefore, this type of learning activity is designed to develop declarative and procedural knowledge in a structured and systematic way (Wardani et al., 2025).

On the other hand, physics learning also requires experimental or laboratory activities to connect theoretical concepts with real phenomena. Through practical activities, students can carry out observations, measurements, and data analysis directly, which helps them develop science process skills (Kriswantoro et al., 2025). These skills include observing, classifying, communicating, measuring, predicting, and drawing conclusions (Candra & Hidayati, 2020). Such activities not only develop skills but also improve students' learning outcomes (Fatimah, 2020; Febrianti et al., 2025; Sofiana, 2021). In addition, practical-based learning can increase student engagement and participation in the learning process (Sahari, 2024; Suciati et al., 2025). These improvements occur because students gain more concrete and meaningful learning experiences and build concepts through empirical experience, making learning more meaningful compared to purely theoretical instruction.

Several previous studies have examined the effectiveness of different learning models in physics. Research conducted by Mauritha (2018) shows that practicum-based learning provides better learning outcomes than conventional learning, using a pre-test and post-test control group design. Other studies also show that the Direct Instruction model can improve students' physics learning outcomes through systematic and structured material delivery (Hasmah, 2017; Lestari et al., 2022). In addition, research on physics practicum indicates that the use of experimental activities can significantly improve students' conceptual understanding and learning outcomes (Febrianti et al., 2025; Lutfiani et al., 2025).

Although many studies have shown the effectiveness of each learning model, most of them still focus on the effect of a single model on learning outcomes without directly comparing it with other models in the same context. In addition, some studies only assess cognitive learning outcomes without examining in detail how different learning approaches affect the overall learning process of students.

Based on these conditions, it is necessary to conduct a study that directly compares the effectiveness of Direct Instruction and practicum-based learning in physics education. This comparison is important to identify which learning model is more effective in improving students' conceptual understanding and learning outcomes, as well as to provide recommendations for teaching strategies that are more suitable for the characteristics of physics material.

The novelty of this study lies in the comparative analysis between Direct Instruction and practicum-based learning within the same research design. Therefore, this study

provides empirical evidence on the effectiveness of both approaches on physics learning outcomes. In addition, this research is expected to contribute to the development of more effective physics teaching strategies by integrating conceptual and experiential approaches in the learning process.

METHOD

Types of research

This type of research is a quasi-experimental study with a pretest and posttest control group design. This study aims to compare the effectiveness of the direct instruction and practicum- based learning.

Time and Place of Research

This research was conducted for 3 months from Januari 2026 to March 2026, located in the SMA Negeri 1 Muaro Jambi.

Population and Sample

The sample involved 16 students from two different classes at SMA Negeri 1 Muaro Jambi in the 2025/2026 academic year. Class XI F6, consisting of 16 students, applied the practicum method, while class XI F10, also consisting of 16 students, used Direct Instruction. Both classes used different learning approaches, namely Direct Instruction and practicum-based learning (Meiliasari & AJ, 2025).

Research Procedures

This study uses a quantitative approach with a quasi-experimental design, specifically the non-equivalent control group design. This design involves two classes: an experimental class (O_1) and a control class (O_3). The experimental class receives learning through conventional practicum, while the control class receives learning using PhET simulation. The experimental design of this study can be seen in Figure 1.

Group	Pre- test	Treatment	Post- test
Experiment	O_1	X_1 →	O_2
Control	O_3	X_2 →	O_4

Figure 1. Research Design

O_1 represents the pre-test score of the experimental class before the conventional practicum, O_2 represents the post-test score after the practicum, O_3 represents the pre-test score of the control class before the treatment, and O_4 represents the post-test score of the control class after the treatment. X1 refers to learning using the practicum method, and X2 refers to Direct Instruction.

Data, Instruments and Data Collection Techniques

This study uses purposive sampling to select the sample from the population. This technique focuses on collecting data that are relevant to the research needs so that the results can provide more comprehensive and detailed information (Subhaktiyasa, 2024). The sample selection is based on several considerations, including balanced academic ability, the availability of learning time, and students' characteristics in understanding the topics of density and hydrostatic pressure (AJ, Furqon, et al., 2025).

The data collection technique used pre-tests and post-tests. The pre-test was conducted before the learning treatment, while the post-test was conducted after the treatment. The test instrument consisted of 10 multiple-choice questions on the topics of density and hydrostatic pressure. The same type of test was used for both the pre-test and post-test in each group. The pre-test was conducted before both classes received different treatments, where the experimental class used the practicum method and the control class used Direct Instruction.

Data Analysis Techniques

The pre-test and post-test results were then collected and analyzed statistically. The data analysis was carried out in two stages, including prerequisite analysis and hypothesis testing. The prerequisite test used a normality test. The normality test is required before conducting parametric tests and aims to determine whether the data are normally distributed (Sari et al., 2024). This normality test used the Kolmogorov–Smirnov method. The decision criteria are that if the significance value is greater than 0.05 (> 0.05), the data are considered normally distributed, and if the significance value is less than 0.05 (< 0.05), the data are not normally distributed.

The next step is hypothesis testing using the N-Gain score and the t-test. The N-Gain score analysis aims to determine the effectiveness of the learning method. This analysis uses the following equation (AJ, Raudhatussya'rifah, et al., 2025; Hake, 1999)

$$N - Gain = \frac{posttest\ score - pretest\ score}{ideal\ score - pretest\ score} \quad (1)$$

The results of the N-Gain Score can be interpreted; the results of the scoring categorization can be seen in Table 1 (Hake, 1999).

Table 1. N- Gain Effectiveness Categories

Percentage (%)	Category
< 40	Ineffective
40 – 55	Less Effective
56 – 75	Fairly Effective
> 76	Effective

The next stage of data analysis is the t-test or the Mann–Whitney U test. The t-test is a statistical technique used to compare the average scores between groups or samples and to determine the significance of the differences (for normally distributed data). However, for data that are not normally distributed, the Mann–Whitney U test is used.

Both tests aim to determine whether there is a significant difference between the mean scores of two independent groups. The analysis is carried out by comparing the pre-test and post-test results between the control class and the experimental class to evaluate the effectiveness of the treatment given.

RESULTS AND DISCUSSION

The research data in this study were obtained from the results of pre-tests and post-tests conducted during Direct Instruction and practicum-based learning activities. Data collection was based on the different treatments given to two groups in different classes. The experimental class used practicum-based learning in class XI F6, while the control class used Direct Instruction in class XI F10. Each class consisted of 16 students, so the number of participants in both groups was balanced to support the comparison of learning outcomes.

Table 2. Pre-test and Post-test in the Experimental Group

Parameters	Experiment Group	
	Pre- Test	Post- Test
Number of Students	30	30
Average	77, 31	91, 67
Maximum Score	96,67	100
Minimal Score	26,67	63,33

The average pre-test and post-test scores in the experimental class can be seen in Table 2. The average pre-test score in the experimental class was 77.55. This result shows that physics learning in class XI F6 before using practicum was already in the effective category. This achievement may be because most students had already understood the physics concepts beforehand. The highest pre-test score was 96.67, while the lowest was 26.67. These results indicate that students had different initial abilities in understanding the concepts (Meiliasari & AJ, 2025). However, the average post-test score increased significantly to 91.59 after the practicum was carried out. The highest and lowest post-test scores were 100 and 63.33, respectively. The improvement occurred for all students, both those with the lowest and the highest scores.

Table 3. Pre-test and Post-test in the Control Group

Parameters	Control Group	
	Pre- Test	Post- Test
Number of Students	30	30
Average	29, 37	35, 83
Maximum Score	96, 67	96,67
Minimal Score	3,33	10,00

The pre-test and post-test results in the control class can be seen in Table 3. The average pre-test score was 29.37, which represents the initial ability of students in class XI F10 and is categorized as low. The minimum and maximum pre-test scores were 3.33 and 96.67, respectively. After the treatment was given, the average post-test score increased to 35.83. The maximum score was 96.67, while the minimum score was 10.00. Further analysis in this study was conducted using statistical methods, including the normality test, N-Gain test, and hypothesis testing. All tests were carried out using IBM SPSS Statistics 26 software. In this analysis, the experimental class was categorized as group 1, while the control class was categorized as group 2.

The first step in the statistical analysis was the normality test, which aimed to determine whether the data were normally distributed. The results of the normality test are presented in Table 4, using the Shapiro–Wilk method. The significance value for the experimental class was 0.011, while for the control class it was 0.00. Based on the decision criteria, where the significance value is less than 0.05, it can be concluded that the data in both groups are not normally distributed. Non-normally distributed data have also been reported by (Istimewa & Wicaksono, 2021), so the analysis was continued using the Mann–Whitney U test.

Table 4. Normality Test Result

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Kelas 1	.241	16	.014	.844	16	.011
Kelas 2	.328	16	.000	.729	16	.000

The results of the prerequisite test show that the data are not normally distributed, so the data were analyzed using the Mann–Whitney U test to determine whether there is a significant difference between the experimental class and the control class. The results of the Mann–Whitney U test can be seen in Table 5. The test shows that the Asymp. Sig. (2-tailed) value is 0.000 < 0.05, which means the significance value is less than 0.05. Therefore, there is a significant difference between the experimental class that used the practicum method and the control class that used conventional learning. These results indicate that the practicum treatment has a significantly different effect.

Table 5. Mann- Whitney U Test Result

Test Statistics

	Result
Mann-Whitney U	19.000
Wilcoxon W	155.000
Z	-4.116
Asymp. Sig. (2-tailed)	.000
Exact Sig. [2*(1-tailed Sig.)]	.000[b]

Further statistical analysis in this study includes hypothesis testing using the N-Gain score. The N-Gain score test is used to evaluate the effectiveness of the learning method in both groups. The results shown in Table 5 indicate that the average learning outcome in the experimental class is 57.37%, while in the control class it is 7.97%. These values indicate that the practicum method is more effective than the conventional method.

Table 6. N- Gain Score

Group	N- Gain Score (%)	Category
Kelas Eksperimen	57, 06	Fairly Effective
Kelas Kontrol	7, 97	Ineffective

Based on several tests conducted on the experimental and control classes, the results show that the experimental class, which used practicum-based learning, experienced an improvement in learning outcomes, had a positive impact, and was quite effective in the learning process. The improvement in the experimental class occurred because students were able to build their own understanding through empirical experience during the practicum. Overall, the analysis shows that practicum-based learning improves students' learning outcomes, making the learning process more effective, meaningful, and impactful.

However, the control class also showed an improvement in learning outcomes, but it was not very significant. This is because the Direct Instruction model mainly focuses on the teacher, who controls the learning process, and involves less student activity. The results of this study are consistent with previous studies Sulfiyah & Cahyaningsih, (2021), Aldila et al., (2026), AJ, Raudhatussya'rifah, et al., (2025), and (Ad et al., 2021), which state that the practicum method has a positive effect and is more effective in improving student achievement.

Other studies also show that students have positive perceptions of physics practicum (Sintiya & Putranta, 2025). Similarly, research by Meiliasari & AJ (2025) shows that practicum-based learning encourages students to be more active in observing and explaining physical phenomena, while Direct Instruction can increase curiosity through structured conceptual explanations. In addition, practicum methods integrated with inquiry have been shown to improve learning outcomes and science process skills of grade XI students at SMAN 1 Pringgarata in the 2018/2019 academic year (Hidayati & Meiliyadi, 2021).

CONCLUSIONS AND SUGGESTIONS

Conclusions

This study shows that practicum-based learning is more effective than Direct Instruction in improving students' learning outcomes. This can be seen from the higher increase in scores in the experimental class and the statistical test results, which show a significant difference between the two groups. The practicum method provides direct experience for students, which helps them understand concepts better, while Direct Instruction tends to involve less student activity, so the improvement is not very significant.

Suggestions

Future research is recommended to cover a wider range of topics and involve a larger sample size. In addition, future studies are expected to integrate practicum-based approaches with digital technology in order to obtain more comprehensive results and stronger generalization.

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