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Comparison of Discovery Learning and Problem-Based Learning Models on Concept Understanding (C1-C4) of Junior High School Students

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Abstract: A teacher must be able to choose a learning model that has the potential to enhance students' understanding of a concept. The purpose of this research is to determine the effects of Discovery Learning (DL) and Problem-Based Learning (PBL) models on the conceptual understanding of junior high school students regarding the material on simple machines. Additionally, this study aims to compare students' understanding when taught using these two models. This quasi-experimental research employs a nonequivalent pretest-posttest control group design, involving two groups of eighth-grade students from a junior high school in Malang Regency for the 2024-2025 academic year. The sampling method used is cluster random sampling. The instruments applied in this study were multiple-choice tests. Several statistical procedures, including normality tests, homogeneity tests, independent sample t-tests, paired samples t-tests, and N-Gain tests, were utilised to analyse the data. The results indicate that both Problem-Based Learning and Discovery Learning positively affect students' conceptual understanding. However, learning through PBL resulted in a higher N-gain (%) in understanding (70.22%) than in the Discovery Learning group (55%). Based on these findings, it can be concluded that the use of DL and PBL can enhance students' understanding of concepts and encourage them to participate more actively in the learning process.

Keywords: Learning Model, Problem-Based Learning, Discovery Learning, Concept Understanding

INTRODUCTION

Competitive and superior human resources are obtained through education. In junior high school education, a deep understanding of concepts is crucial for building a strong foundation for students to face more complex subject matter at higher levels. However, students often struggle to grasp basic concepts, especially in science subjects like physics (Paudi, 2020). One of the main aspects of education is the quality and outcomes of learning (Paramitha et al., 2023). Wabula et al (2020) explain that an educator must have the ability to choose an appropriate teaching model, considering the conditions of the students, the material, and the learning resources. This is done to ensure that the learning model has the potential to be effectively used to enhance students' conceptual understanding.

Low teaching outcomes among students indicate an inability to deliver the educational process effectively to achieve learning objectives (Paramitha et al., 2023). Learning generally centers around the teacher rather than focusing on the students, resulting in monotonous teaching that leads to ignorance and a lack of understanding among students. The education provided in schools often does not meet expectations. The classroom education process is very passive, as it only involves listening, completing tasks, and focusing on textbooks (Ariyani & Kristin, 2021). Students absorb and remember information only during exams (Paputungan et al 2022). As highlighted in a case study by Ardianto et al (2019), many students do not meet the Minimum Completeness Criteria (KKM) during the learning process. Furthermore, there is little classroom learning activity, and conventional teaching models are still used, making it difficult for students to understand the subject matter. Most students ignore the teacher, merely retain information, are reluctant to ask questions, chat with friends, and only receive practice problems from the teacher, which they then complete.

A case study by Sulastry et al. (2023) indicates that, because students are dominated by receiving material directly from the teacher, educators cannot focus on students, resulting in students' inability to develop new understandings from existing theories. Consequently, students find it challenging to grasp concepts. Another case study by Irda et al (2023) reveals that students at SMPN 1 Lawa have a low understanding of simple machines, with only 5.8% demonstrating comprehension. Students' limited knowledge of simple machines is evident. It is estimated that a lack of student understanding leads to disinterest in learning, making it difficult to grasp concepts and identify misconceptions.

The effectiveness of the learning model is essential for fostering students' desire to learn and sparking their curiosity. A practical and suitable teaching model can enhance students' motivation to learn and stimulate their curiosity about the topics studied, leading to a longer retention of the concepts learned (Sari et al., 2021). The effectiveness of the learning model significantly influences student engagement in the learning process. Using the proper methods, students become not only motivated to learn but also more actively participate in discussions and exploration of the material, deepening their understanding.

The recommended learning models in the independent curriculum include Blended Learning, Discovery Learning, Inquiry Learning, Problem-Based Learning (Rohmah et al., 2025), and Project-Based Learning (Bawadi et al., 2023). Each model allows for the development of attitudes, knowledge, and skills. The PBL and DL models are among several solutions in this study. This is because both scientific approach models are based on a problem and emphasise the importance of students taking an active role during the learning process. While PBL focuses on solving real-life issues related to students' daily lives, the DL model encourages students to explore concepts through experience. Both have their advantages and challenges, and choosing the right model can significantly affect students' understanding.

Discovery Learning is a method where students acquire scientific skills and are guided to discover ideas. DL learning tends to be carried out independently by students, but it is not without teacher supervision (Adinata et al, 2022). DL focuses on discovering principles and understanding previously unknown ideas. In this case, the teacher intentionally designs problems for students to solve (Afnan & Syamsudin, 2022). Students can gain knowledge through experiences and interactions with their environment when they actively participate during the learning process. Curiosity is an essential component of effective learning. Therefore, students will remember what they learn for a long time, and the results are not easily forgotten. An efficient method for enhancing students' knowledge through direct experience, exploration, and investigation is through DL learning (Sayangan et al., 2024). This process provides students with opportunities to learn actively and find solutions to existing problems.

The DL learning model can help improve understanding of concepts taught in VIII grade science lessons (Saputri, 2023). By using the DL learning model, students will more actively understand concepts through observation or experimentation. Additionally, this model may broaden and enrich students' understanding of science. The syntax of DL learning includes stimulus (providing stimulation), identifying problems, processing data, verifying data, and drawing conclusions (Bruner, 1961).

Problem-Based Learning is a teaching model that enables students to develop problem-solving and critical thinking skills in the context of real-world problems. This approach also allows students to gain conceptual understanding and essential knowledge from the subject matter (Wibowo, 2018). PBL is an active learning model that emphasises the importance of acquiring knowledge through problem-solving activities, independent study, and small group discussions. Teachers play a crucial role in PBL, as they not only help students learn to solve problems but also to collaborate, study independently, and discover their intrinsic motivation (Shimomura & Utsumi, 2025). PBL is a learning process that enables students to understand concepts through problems (Silvi et al., 2020).

PBL involves students seeking solutions to problems, activating them, and encouraging them to be creative in their search (Sintya Devi & Wira Bayu, 2020). This allows students to be more active in learning. As a result, their creative and critical thinking skills are strengthened, as is their ability to solve problems in real-world situations (Hidayati et al., 2024). By utilising the PBL learning model, students' understanding can be enhanced because they are motivated to find their own solutions to the problems presented (Syarifah et al, 2020).

PBL is largely self-directed. In groups, students collaborate to identify sub-problems, analyse them, and find the facts and information needed to create solutions and address learning problems. Ultimately, students are responsible for solving problems using the knowledge they have acquired (Karttunen et al., 2025). Therefore, the knowledge students create for themselves will remain embedded in their memory for a long time. If students have a strong understanding of the topics studied, they will have better learning capabilities (Supiandi & Julung, 2016). Students will feel interested and motivated to solve these problems because PBL presents real-world issues that require solutions (Silalahi et al., 2023). Orienting students toward problems, managing/organising students, guiding them during investigations, developing and demonstrating results, analysing, and evaluating problem-solving are all parts of the PBL learning process (Lestari et al., 2023).

Previous research has compared the two innovative models of Discovery Learning (DL) and PBL. A study by Gani et al. (2021) reported that in the 2019/2020 academic year, fourth-grade students at SDN Bojongrangkas 01 in Bogor district showed significant improvement in learning about biodiversity in the environment when using the DL and PBL models. The results indicate that students using the Discovery Learning model performed better than those using the PBL model. Furthermore, Paramitha et al. (2023) reported that both DL and PBL models impact conceptual understanding, with students in class XI IPS at a high school in Bojonegoro district during the 2021-2022 academic year showing differences between the two models. Classes using PBL achieved higher grades than those using the DL model. Wabula et al. (2020) support the finding that the PBL model is superior to the DL model in enhancing conceptual understanding. This was conducted in class X at SMA Negeri 1 Ambon. In the PBL class, the average cognitive, psychomotor, and affective scores were higher than in classes using the Discovery Learning model. Another study by Chodijah et al. (2019) indicated that in class XI with science subjects, the Problem-Based Learning (PBL) model is more efficient than the DL model. Although many studies have compared these two learning models across educational levels, such as elementary and high school, no study has specifically examined the effectiveness of DL and PBL in science learning at the junior high school level, particularly for physics material. Previous research, such as that conducted by Gani et al. (2021), Paramitha et al. (2023), Wabula et al. (2020), and Chodijah et al. (2019), shows varied results depending on the level and material studied.

Additionally, previous research at the junior high school level by Junaid et al., (2021) and Siahaan & Sihotang (2023) only investigated one learning model without comparing both teaching models, thus not determining which learning model is most suitable and adequate for enhancing students' conceptual understanding. Junaid et al., (2021) conducted research on the effect of PBL in seventh-grade students at SMPN 17 Tebo on their knowledge of science concepts in the 2020/2021 academic year, finding a significant impact of implementing problem-based learning on seventh-grade students' understanding of physics concepts at SMPN 17 Tebo. Meanwhile, Siahaan & Sihotang (2023) investigated the effect of the discovery learning model on students at SMP Satrya Budi Perdagangan, enhancing their understanding of science concepts. The DL model improved students' knowledge of science, with the final results indicating an average score of 80%.

It is hoped that this study will determine which learning model is superior and serve as a reference for educators in selecting a more effective model to enhance junior high school students' conceptual understanding. Based on these issues, the researcher continues the study with junior high school students, aiming to determine the impact of the Discovery Learning and Problem-Based Learning models on students' conceptual understanding of simple machines and to compare students' knowledge between those taught with both models.

METHOD

This research is a quasi-experiment comparing the Discovery Learning (DL) and Problem-Based Learning (PBL) models in junior high school students' understanding of concepts related to simple machines. The nonequivalent pretest-posttest control group design is used because it allows the researcher to compare two groups that are not randomly assigned, namely the group receiving the DL model treatment and the group receiving the PBL model treatment. Students in the experimental group 1 received the DL treatment, while experimental group 2 received the PBL treatment, studied using this design or concept (Karmila et al., 2020). This design involves measuring before the treatment (pretest) and after the treatment (posttest) for both groups.

The research population comprises all eighth-grade students in junior high schools. The study was conducted in two classes over two weeks. Meetings consisted of two face-to-face sessions in the classroom to deliver the learning models to both experimental classes 1 and 2. The learning duration was 5×35 minutes. The samples in this study are students from classes VIII B and VIII C. The DL model was used to teach class VIII B, while the PBL model was used for class VIII C. The samples were collected using cluster random sampling, ensuring that the class characteristics align with the research objectives. The use of cluster random sampling in this study was chosen because the research population consists of all eighth-grade junior high school students divided into clear groups (clusters), namely eighth-grade classes. Classes VIII B and VIII C were randomly selected as clusters, where each class (VIII B and VIII C) is considered one cluster (Trochim & Donnelly, 2006).

Table 1. *Nonequivalent pretest-posttest control group design*

Group/Class	Pretest	Treatment	Posttest
Experiment 1	O_1	x	O_2
Experiment 2	O_1	y	O_2

Before being used to test conceptual understanding, the research instrument underwent validation, validity, and reliability tests. The reliability of the validation results for the teaching modules was calculated using inter-rater reliability with a similarity percentage technique among validators.

Table 2. Percentage of Similarity in Validation of Discovery Learning and Problem-Based Learning Teaching Modules

	Model	Aspect			Avarage	Criteria
% Similarity	DL	88%	99%	100%	96%	Almost Perfect
	PBL	91%	99%	100%	97%	Almost Perfect

Based on the aspects of general information, core components, and appendices, a result of 96% was obtained, indicating an almost perfect level of similarity. The discovery learning-based teaching module was used for learning in experimental class 1 and PBL in experimental class 2. In this study, multiple-choice questions totalling 20 items have been validated and empirically tested.

Table 3. Empirical Test of Discovery Learning and Problem-Based Learning Questions

Question DL				Question PBL			
Question	r_{xy}	r_{tabel}	Reliability	Question	r_{xy}	r_{tabel}	Reliability
1	0.523	0.455	0,877	1	0.755	0.468	0,697
2	0.546	0.455		2	0.553	0.468	
3	0.468	0.455		3	0.553	0.468	
4	0.684	0.455		4	0.534	0.468	
5	0.805	0.455		5	0.603	0.468	
6	0.843	0.455		6	0.529	0.468	
7	0.843	0.455		7	0.670	0.468	
8	0.843	0.455		8	0.659	0.468	
9	0.609	0.455		9	0.924	0.468	
10	0.808	0.455		10	0.572	0.468	

Based on the calculation where rxy > rtabel and the reliability test results indicating a Cronbach's Alpha value > 0.60 (Alfajri et al., 2019), it can be concluded that the 10 tested questions have met the validity and reliability criteria. Therefore, this test instrument can be considered valid and reliable for use in this research. After these questions met the validity and reliability criteria, they can be used to assess students' conceptual understanding in both experimental classes through pretest and posttest. The instrument for measuring students' knowledge of concepts is multiple-choice questions. The questions were created based on indicators of conceptual understanding.

Data were analysed using t-tests (Paired samples t-test and Independent Sample t-test) after conducting normality tests (Shapiro-Wilk) and homogeneity tests (Levene's). The paired-samples t-test was used to determine whether there was an effect of both the DL and PBL models on understanding a concept, while the independent-samples t-test compared the two models. The N-Gain test was used to measure the improvement in conceptual understanding based on pretest and posttest results. The N-gain results were then categorised according to Hake's (1998) criteria, as shown in Table 4.

Table 4. N Gain Score Categories (Hake, 1998)

N Gain Score	Category	N-Gain Score	Category
Score < 0.3	Low Improvement	< 40%	Ineffective
0.3 ≤ score < 0.7	Moderate Improvement	40-50%	Less Effective
Score ≥ 0.7	High Improvement	56-75%	Quite Effective
		≥ 76%	Effective

RESULTS AND DISCUSSION

The data collected in this study consist of quantitative data, including test scores from both classes, and were analysed using an Independent Samples t-test. The purpose of this analysis is to identify differences in average conceptual understanding between students in experimental classes 1 and 2 by measuring participants' initial abilities through pretests and changes in their conceptual knowledge scores. However, before conducting the independent samples t-test, the data must first be tested for normality and homogeneity. The results are presented in Figure 1.

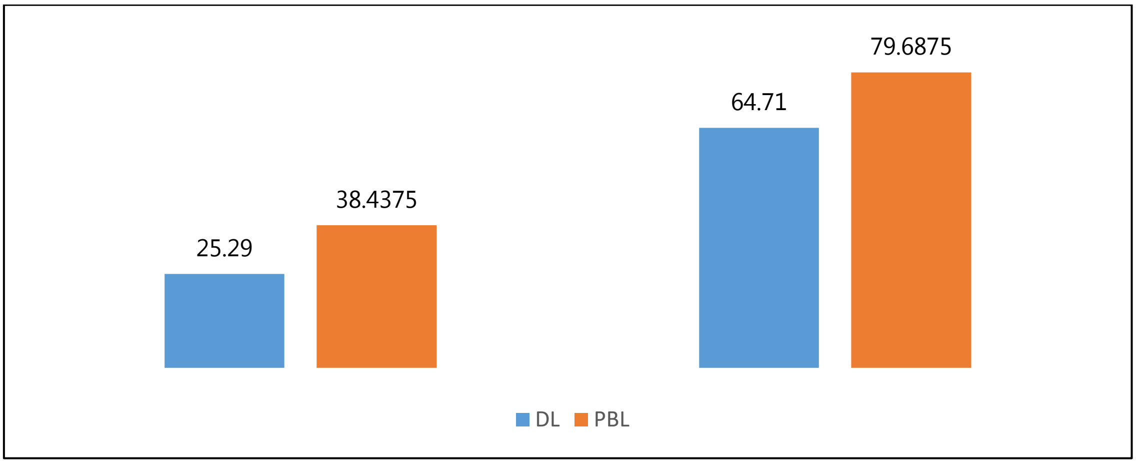

Figure 1. Average Pretest-Posttest Results for PBL & DL

Figure 1 shows that the average pretest score for experimental class 1 was 25.29 before teaching using the Discovery Learning (DL) model. After applying the DL model, the average posttest score for group 1 increased to 64.71. In experimental class 2, with the Problem-Based Learning (PBL) approach, the average pretest score before treatment was 38.44. After using the PBL model, the average posttest score for group 2 also increased to 79.69. Once the pretest data from experimental class 1 and the conceptual understanding results from class 2 were collected, the next step was to conduct normality testing (Shapiro-Wilk test) and homogeneity testing using SPSS version 23, as shown in Tables 5 and 6.

Table 5. Normality and Homogeneity Tests

Test	Class	Sig (Normality)	df_1	df_2	Sig (Homogeneity)
Pretest	Experiment 1	0,69	1	64	0,364
	Experiment 2	0,50			
Posttest	Experiment 1	0,83	1	64	0,744
	Experiment 2	0,90			

Based on the results in Table 5, the normality test indicated that the significance values for both pretest and posttest data in each class were greater than 0.05. Similarly, the homogeneity test also showed significance values greater than 0.05. This means that the data can be considered normal and homogeneous (Qurnia Sari et al., 2017). After confirming that the data were regular and homogeneous, the next step was to conduct the t-test.

The Impact of the Discovery Learning Model on Students' Conceptual Understanding

To analyse the effect of the DL model on students' conceptual understanding, a Paired Samples t-test was used. The results of this test showed a significance value (sig. 2-tailed) of 0.000. Since $0.000 < 0.05$ ($\alpha = 0.05$) (Fauzi et al., 2021). This indicates a significant difference between the pretest and posttest scores. After implementing the

DL model, students demonstrated a different level of conceptual understanding compared to before. The increase in students' conceptual understanding is also evident from the average pretest score of 25.88 and the average posttest score of 64.71 ($\bar{X}_{Post} > \bar{X}_{Pre}$). Thus, the application of the Discovery Learning model positively affects students' understanding of concepts related to simple machines, meaning that H_0 is rejected and H_a is accepted. Students who received this treatment showed a significant improvement in their knowledge after participating in the lessons. This aligns with previous research by Saputri (2023), which indicated that the discovery learning model can help improve the conceptual understanding of eighth-grade students in science at SMP Negeri 13 Makassar.

The syntax used in the discovery learning model also contributes to better conceptual understanding. The stimuli provided through videos and simple experiments successfully boosted students' curiosity within this model. During the problem identification stage, students exhibited strong questioning skills, prompting further research. They were very interested in collecting data and actively sought references to validate their understanding, which contributed to better scores in the post-test. Students demonstrated the ability to analyse data and apply the physics concepts they had learned during the data processing phase. Moreover, they showed meticulousness in verifying the accuracy of their answers during the verification phase.

Despite some challenges, such as a lack of confidence hindering active participation, this model is deemed less effective in conceptual understanding, according to Table 7. Overall results indicate that the DL model can enhance students' conceptual understanding, as noted by Suryaningrum (2023), who explained that the DL model helps students become active in grasping what they learn. Students deepen their understanding of concepts through observation and experiments using the DL model. This model also has the potential to enhance knowledge and make science concepts more enjoyable.

The Impact of the Problem-Based Learning Model on Students' Conceptual Understanding

A Paired Samples t-test was employed to analyse the impact of the PBL model on students' conceptual understanding. The analysis results revealed a significance value (sig. 2-tailed) of 0.000 for the comparison of pretest and posttest scores. Since the significance value of 0.000 is less than α ($0.000 < 0.05$), it can be concluded that there is a significant difference between the pretest and posttest scores. After implementing the PBL model, students exhibited a noticeable improvement in their conceptual understanding compared to before.

This improvement is reflected in the average pretest score of 38.53 and the average posttest score of 78.53, thus indicating that ($\bar{X}_{Post} > \bar{X}_{Pre}$). This shows that the PBL model has a positive impact on students' understanding, meaning that the null hypothesis (H_0) s rejected and the alternative hypothesis (H_a) is accepted. In other words, the application of the PBL model successfully enhances students' conceptual understanding during the learning process in experimental group 2. This provides empirical evidence that the PBL model is effective in supporting deeper and more interactive learning, which can enhance students' conceptual understanding. This is consistent with previous research by Junaid et al (2021) which found a significant effect of PBL implementation on seventh-grade students' understanding of physics concepts at SMPN 17 Tebo. Wibowo (2018) also stated that PBL is a learning approach that enables students to develop problem-solving and critical thinking skills in the context of real-world problems. This approach allows students to gain conceptual understanding and essential knowledge from the subject matter.

PBL significantly enhances students' understanding, starting with the presentation of videos about real problems that stimulate curiosity and encourage students to ask questions. Students show interest in conducting simple experiments and actively asking questions, especially when using tools like simple devices and Phet practical links. Working on physics problems increases students' desire to seek information, while the use of crossword puzzles reinforces critical thinking and collaboration. In the development and presentation stage, students are able to convey information effectively, strengthening their understanding. Finally, discussions and feedback during problem analysis enhance students' critical thinking skills.

The research findings indicate that PBL not only boosts student interest and participation but also their analytical abilities, in line with findings from other studies by Junaid et al (2021) which emphasises the effectiveness of this method in learning. This model is considered quite effective and shows an impact on understanding, as indicated in Table 7. This aligns with Syarifah etal. (2020), who stated that utilizing the PBL model can enhance students' understanding because they are motivated to find solutions independently to the problems presented. PBL is a learning process that enables students to understand concepts through problems (Silvi et al., 2020).

Comparison Between the Discovery Learning and Problem-Based Learning Models

The study compared the effectiveness of two learning models, namely DL and PBL, in improving students' conceptual understanding. To assess differences, an independent samples t-test was conducted, which is the appropriate statistical method for comparing two groups. The results of this test will indicate the extent to which differences in conceptual understanding between students taught using both models are statistically significant. Below are the results of the independent samples t-test that was conducted:

Table 6. Independent samples t-test

Test	Class		Sig.(2-tailed)
Pretest	Experiment 1 Experiment 2	Equal variances assumed	0,014
Posttest	Experiment 1 Experiment 2	Equal variances assumed	0,008

According to Table 6, the results of the independent samples t-test show a Sig. (2-tailed) value for the pretest of 0.014 < α (0.05). This indicates a difference in students' conceptual understanding between the DL and PBL model classes, as measured by pretest scores–similarly, the Sig. (2-tailed) value for the posttest is 0.008 < α (0.05). This indicates a notable difference in posttest scores between the DL and PBL model classes.

To compare the results of conceptual understanding between the two learning models, an n-gain test was conducted. The primary purpose of this test is to measure each model's effectiveness in enhancing students' understanding by comparing pretest and posttest scores. The results of the n-gain analysis will provide a clear picture of the improvement students achieved after participating in the learning process for each model. The following n-gain test results show the average results for experimental classes 1 and 2.

Table 7. Average Results of Comparison Between Experimental Groups 1 and 2

Model	Average		Improvement	N-gain	Conclusion
	pretest	posttest			
DL	25,29	64,71	39,42	53%	Less effective with moderate improvement
PBL	38,44	79,69	41,25	70,22%	Quite effective with high improvement

Table 7 shows that the average pretest for the DL group is 25.29, while the average posttest is 64.71, resulting in an improvement of 39.42. Despite this improvement, the n-gain for the DL group reaches only 53%, indicating that this model is considered less effective. Conversely, the PBL group shows an average pretest score of 38.44 and a posttest score of 79.69, representing an improvement of 41.25. The n-gain for the PBL group reaches 70.22%, indicating that this model is quite effective in enhancing students' understanding.

Furthermore, Table 7 provides a more detailed overview of the average test improvements between experimental classes 1 and 2. The DL group shows a moderate improvement, indicated by an n-gain of 0.5300. On the other hand, the PBL group demonstrates a more significant progress, with an n-gain of 0.7022, indicating a high level of improvement. These results suggest that the PBL learning model is more efficient at enhancing students' conceptual understanding than the DL model.

This research shows that the PBL model is more effective than the discovery learning (DL) model in improving students' conceptual understanding, which means that H_0 is rejected and H_a is accepted. The average posttest score for PBL is 79.69, with an n-gain of 70.22%, whereas DL achieves 64.71 with an n-gain of 53%. This also aligns with previous research comparing these two innovative models, where Wabula et al., (2020) Confirmed that the PBL model is more effective than DL in enhancing students' understanding. Research conducted in class X at SMA Negeri 1 Ambon showed that the PBL group outperformed the discovery learning group in cognitive, psychomotor, and affective skills. Another study by Paramitha et al (2023) also stated that students taught using the PBL model had higher conceptual understanding than those taught using the DL model in social studies for eleventh-grade students. Similarly, another study by Chodijah etal. (2019) found that the Problem-Based Learning (PBL) model is more effective than the discovery learning model in science subjects for eleventh-grade students.

This is also in line with their learning experiences in experimental class 2, where PBL effectively encourages collaboration and discussion among students, enhancing their engagement in the learning process. This approach creates a more interactive learning experience in which students are directly involved in solving real problems. In contrast, DL tends to show a lack of student enthusiasm despite the stimuli provided. Although simple experiments and material exploration through media can enhance students' active attitudes, some students still struggle to understand the concepts being taught. Thus, PBL is superior to DL because it not only increases active student participation but also helps students understand the material more deeply through observation and direct experimentation to solve real problems. Adinata et al (2022) stated that discovery learning tends to be conducted independently and requires intensive teacher guidance. Additionally, activities in PBL involve experiments and practical work, which aligns with Saraswati et al (2018), who noted that in the learning pyramid, material is more easily absorbed when students conduct observations and experiments directly. Therefore, it can be concluded that PBL creates a more collaborative and interactive learning environment, while DL faces challenges in maintaining student motivation and understanding.

CONCLUSIONS

The results of this study indicate that the use of the Discovery Learning (DL) and Problem-Based Learning (PBL) models has a positive impact on understanding simple machines. Although the findings show that the PBL model is more efficient than the DL model, this does not mean teachers should recommend using the PBL model exclusively for teaching this material. Both models have proven effective and can be utilised in teaching simple machines. However, there is initial evidence that PBL tends to be more effective. Nonetheless, firm conclusions about this comparison need to be verified through further research involving a larger and more diverse student population.

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