DOI: 10.14421/impulse.2026.61-02

IMPULSE: Journal of Research and Innovation in Physics Education
Volume 6, Issue 1, 17 – 27

© ISSN (p): 2798–1762; ISSN (e): 2798-1754
http://ejournal.uin-suka.ac.id/tarbiyah/impulse

The Effect of the Predict-Discuss-Explain-Observe-Discuss-Explain (PDEODE) Learning Model on Students' Understanding of Physics Concepts in Temperature and Heat Material for Grade XI at SMAN 10 Bone

A. Noorshafira Safitri Jamal*, Sudirman, Muh. Syihab Ikbal, Tiara

Physics Education Study Program, Faculty of Tarbiyah and Teacher Training, UIN Alauddin Makassar, Indonesia
*Corresponding author: andinoorshafirasafitrijamal@gmail.com

ABSTRACT

This research was motivated by the persistent gap in assessing students' conceptual understanding, particularly on the topic of temperature and heat. Although the PDEODE learning model has been widely reported to improve learning outcomes, many previous studies have not examined indicators of conceptual understanding in depth or compared them comprehensively with conventional learning approaches. Therefore, this study aims to determine the differences in students' understanding of physics concepts between those taught using the PDEODE model and those taught using conventional methods in grade XI at SMAN 10 Bone. This research employed a quasi-experimental design with a quantitative approach, specifically the Matching Only Posttest Control Group Design. The sample consisted of two classes selected through a two-step matching sampling technique, namely the experimental class and the control class. The research instrument was a multiple-choice test consisting of 20 validated items. Data were analyzed using both descriptive and inferential statistics, including normality tests, homogeneity tests, and hypothesis testing. The hypothesis test used was the Mann-Whitney test, which resulted in an Asymp Sig. (2-tailed) value of 0.049, indicating that the p-value is smaller than the significance level of 0.05. The findings revealed that the average conceptual understanding score of students in the experimental class was 68.12 (good category), while the control class scored 59.79 (moderate category). These results indicate that students taught using the PDEODE model demonstrated higher conceptual understanding. Therefore, it can be concluded that the PDEODE learning model positively influences students' understanding of physics concepts.

INTISARI

Penelitian ini dilatarbelakangi oleh adanya kesenjangan dalam menilai pemahaman konsep peserta didik, khususnya pada materi suhu dan kalor. Meskipun model pembelajaran PDEODE telah banyak dilaporkan mampu meningkatkan hasil belajar, sebagian besar penelitian sebelumnya belum

ARTICLE HISTORY
Received: April 9, 2026
Accepted: April 27, 2026

KEYWORDS:
Concept Understanding, PDEODE Learning Model, Temperature and Heat

KATA KUNCI:
Model Pembelajaran PDEODE, Pemahaman Konsep, Suhu dan kalor

* Corresponding author:
A. Noorshafira Safitri Jamal, Physics Education Study Program, Faculty of Tarbiyah and Teacher Training, UIN Alauddin Makassar, Indonesia
✉ andinoorshafirasafitrijamal@gmail.com ✆ +62 82-1774-08274

mengkaji indikator pemahaman konsep secara mendalam serta belum membandingkannya secara komprehensif dengan pembelajaran konvensional. Oleh karena itu, penelitian ini bertujuan untuk mengetahui perbedaan pemahaman konsep fisika antara peserta didik yang diajar menggunakan model PDEODE dan model konvensional pada kelas XI di SMAN 10 Bone. Jenis penelitian ini adalah quasi eksperimen dengan pendekatan kunatitatif menggunakan desain The Matching Only Posttest Control Group Design. Sampel penelotian terdiri dari dua kelas yang dipilih melalui teknik Two-Step Matching Sampling, yaitu, kelas eksperimen dan kelas kontrol. Instrumen penelitian berupa tes pilihan ganda sebanyak 20 butir soal yang telah divalidasi. Analisis data dilakukan secara deskriptif dan inferensial melalui uji normalitas, uji homogenitas, dan uji hipotesis. Uji hipotesis yang digunakan adalah Uji Maan-Whitney dengan nilai Asymp Sig (2-tailed) sebesar 0,049, yang menunjukkan bahwa nilai p lebih kecil dari taraf signifikansi 0,05. Hasil penelitian menunjukkan bahwa rata-rata pemahaman konsep peserta didik pada kelas eksperimen 68,12 dengan kategori baik baik, sedangkan pada kelas kontrol sebesar 59,79 dengan kategori cukup.. Hal ini menunjukkan bahwa pemahaman konsep fisika peserta didik pada kelas eksperimen lebih tinggi dibandingkan kelas kontrol. Dengan demikian, dapat disimpullkan bahwa model pembelajaran PDEODE berpengaruh positif terhadap pemahaman konsep fisika peserta didik.

A. Introduction

The presence of qualified educators is crucial for the continuity of quality learning. Planning, implementing, and evaluating the learning process are the responsibility of educators. Educators create a meaningful, enjoyable, innovative, dynamic, and dialogical learning environment as part of their responsibilities (Siahaan et al., 2025). The goal of science (physics) learning is to foster students' scientific values and attitudes and to develop the skills necessary to acquire physics concepts (Isti'anah et al., 2024).

Interviews with Physics teachers at SMA Negeri 10 Bone revealed that students' conceptual understanding was still lacking because they had not yet reached the learning completion standard, as evidenced by the results being below the Minimum Competency (KKM) (75), namely 60% of 69 students failed to achieve the standard. This was due to limited learning with situations such as learning methods, the use of inadequate facilities such as projectors and minimal direct practice due to incomplete tools.

In general, low knowledge of physics material is due to the use of inappropriate learning strategies or media (Gay et al., 2022). Students can be said to have conceptual understanding if the concept can be explained, recognized, and given examples. By applying conceptual understanding skills, it is hoped that various interrelated mathematical concepts can be explained in depth. In learning, the ability to understand a concept is considered a crucial part, explaining that the subject matter taught is not simply memorized but also understood through conceptual understanding (Setiani et al., 2022).

The limitations of previous research, which generally only emphasize cognitive learning outcomes without examining in-depth indicators of conceptual understanding, require a more comprehensive learning solution. In addition, various studies also show that students still often experience fundamental misunderstandings regarding the concepts of temperature and heat. This condition indicates that conventional learning models have not been fully able to facilitate changes in student conceptualization optimally. Therefore, the application of the Predict-Discuss-Explain-Observe-Discuss-Explain (PDEODE) learning model is a relevant alternative solution because it is able to encourage active student involvement. PDEODE learning can develop self-confidence, logistical thinking, creativity, and improve students' conceptual understanding. This is in line with the findings of Zulham et al. (2023) in their research, which showed that critical thinking skills can be improved and have a positive influence by using the PDEODE model. This aligns with the findings of Mailani et al. (2022) whose research shows that the PDEODE model (Prediction–Discussion–Explanation–Observation–Discussion–Explanation) is often used to encourage students to actively construct their understanding through a process of prediction, discussion, and observation, which can improve conceptualization.

This general research aims to obtain an overview of the level of students' conceptual understanding of temperature and heat taught using the PDEODE model and those taught using the conventional model, and is directed to identify differences in the level of students' understanding of physics concepts from the application of the two learning models. From the research objectives above, it is concluded that the application of the PDEODE model, which can emphasize the active involvement of students through the stages of prediction, discussion, explanation, observation, and drawing conclusions, so that learning becomes more meaningful and based on direct experience (Alabdulaziz, 2022). The importance of understanding concepts so that students have the ability to understand concepts and apply knowledge to real life by paying attention to the environment (Asyhari & Harianti, 2023). Through this process, students not only receive but also build their own knowledge by connecting the concepts learned with real-world phenomena in their environment (Chimmalee & Anupan, 2024). In addition, the PDEODE model can help students evaluate their previous knowledge, re-examine their ideas in group discussions (Samsudin et al., 2020), so that it can increase students' self - confidence, critical thinking attitudes and understanding (Sarwendah et al., 2022). Thus, the application of the PDEODE model in physics learning can significantly improve conceptual understanding, logical thinking skills, and student learning outcomes (Marfu'ah et al., 2022).

B. Method

This study used a quantitative approach, with data collected in numerical form and analyzed statistically (Sugiyono, 2022). This study employed a quasi-

experimental design, with both an experimental and a control group. This study was conducted at SMAN 10 Bone, Bone Regency, during the odd semester of the 2025/2026 academic year.

The population of this study consisted of all eleventh-grade students, with the sample comprising two classes selected using the Two-Step Matching Sampling technique, which ensures equivalence of initial characteristics, particularly students' average academic performance. In this study, the independent variable is the Predict–Discuss–Explain–Observe–Discuss–Explain (PDEODE) learning model, a constructivist approach that actively engages students through six stages: (1) Predict, where students formulate predictions about a phenomenon; (2) Discuss, where they discuss their predictions in groups; (3) Explain, where they provide initial explanations; (4) Observe, where they conduct observations through experiments or demonstrations; (5) Discuss, where they re-evaluate their findings; and (6) Explain, where they refine and strengthen their conceptual understanding (Sarwendah et al., 2022). The dependent variable is students' conceptual understanding, defined as their ability to translate, interpret, and extrapolate concepts related to temperature and heat in a scientifically consistent manner, based on Bloom's taxonomy.

Class XI-1 was assigned as the experimental group and taught using the PDEODE model, while Class XI-2 served as the control group and was taught using conventional methods. Initially, the number of students in each class was 35 and 34, respectively. However, in the data analysis stage (as presented in Table 5), the sample size was reduced to 24 students in each group. This adjustment was due to the application of the matching sampling technique, where only students who had equivalent pairs across both groups were included in the final analysis. In addition, a data cleaning process may have been conducted, such as excluding incomplete responses or data that did not meet the analysis criteria, resulting in the removal of several participants. This clarification is essential to maintain the validity and credibility of the research findings.

The study was conducted over several structured instructional sessions. In the experimental class, the PDEODE model was implemented systematically in each session, involving prediction activities, group discussions, conceptual explanations, and observation through experiments related to temperature and heat. Meanwhile, the control class followed conventional teacher-centered instruction, primarily using lectures and question-and-answer methods. The research instrument used was a multiple-choice test developed based on indicators of conceptual understanding proposed by Benjamin S. Bloom, namely translation, interpretation, and extrapolation (Bloom et al., 2001).

The validity test in this study used empirical validation, which involves testing the instrument through a trial with respondents and analyzing it statistically to determine the extent to which each item accurately measures the intended concept.

This validation is typically conducted by examining the correlation between item scores and total scores, where items with high correlation coefficients are considered valid, while those with low values are revised or eliminated. Meanwhile, instrument reliability was tested using the Cronbach's Alpha formula with the help of SPSS 20.0 to assess internal consistency among items. The Alpha coefficient ranges from 0 to 1, with higher values indicating better reliability; generally, an instrument is considered reliable if the Alpha value is ≥ 0.70. Therefore, these validity and reliability tests ensure that the instrument is both accurate and consistent in measuring students' conceptual understanding. Data analysis was performed using the Kolmogorov-Smirnov test in SPSS 20.0 to check data normality. The decision criterion was that if the Sig value > 0.05, the data were considered normally distributed. Because the data were not normally distributed, the Mann-Whitney U test was used to test the hypothesis with the help of SPSS 20.0.

C. Result and Discussion

Before the instrument was used to collect data, the researcher first conducted observations at the school to identify existing problems. Subsequently, the instrument was developed based on indicators of conceptual understanding, referring to constructivist theory underlying the PDEODE learning model and supported by findings from previous studies. After that, the instrument underwent a series of tests beginning with empirical validation to ensure that each item accurately measured the intended construct. Thus, the development of the instrument was not only technical in nature but also connected to theoretical frameworks and prior research, thereby strengthening the relevance of the model being examined.

Validity testing was used to ensure that the test items accurately measured students' conceptual understanding, in line with learning outcomes. With 69 respondents, the validity test used a Pearson Product-Moment correlation between each item score and the total score, applying a significance level of $\alpha = 0.05$. Under these conditions, the r-table value used was 0.235.

Of the 30 questions described in Table 1, only one was found to be invalid. The researchers then selected 20 of the 29 valid questions to use as a conceptual understanding test instrument. The validity test results are presented in Table 1 below:

Table 1. Results Validity Test

Items	Result	Criteria	Items	Result	Criteria	Items	Result	Criteria
1	0.330	V	11	0.659	V	21	0.387	V
2	0.732	V	12	0.659	V	22	0.466	V
3	0.270	V	13	0.334	V	23	0.461	V
4	0.738	V	14	0.687	V	24	0.678	V
5	0.306	V	15	0.338	V	25	0.656	V
6	0.379	V	16	0.529	V	26	0.524	V
7	0.484	V	17	0.438	V	27	0.271	V
8	0.671	V	18	0.788	V	28	0.434	V
9	0.358	V	19	0.699	V	29	0.435	V
10	0.772	V	20	0.011	IV	30	0.421	V

Note: V = Valid, IV = Invalid

The valid test shows high validity which can be found in item 10 which has a correlation coefficient of r = 0.772 and item 18 with r = 0.788. This means that these items can be used as assessment instruments in future studies and are also effective in distinguishing between students who understand the concepts of temperature and heat and those who do not. In addition, the reliability test results indicate that the instrument has good internal consistency, as shown by the Cronbach's Alpha coefficient falling within a high category (≥ 0.70). This suggests that the items are consistently measuring the same construct, and therefore, the data produced can be considered stable and reliable for research purposes.

Table 2. Results of the Normality Test

		Group	
		Control	Experiment
Kolmogorof-Smirnov[a]	Statistic	0.182	0.215
	df	24	24
	Sig.	0.038	0.005

Based on the results of the normality test shown in the table, it can be seen that the significance value of the experimental class is 0.005 < 0.05 and the control class is 0.038 < 0.05, therefore, the data in the experimental class and the control class are not normally distributed.

Table 3. Results of the Homogeneity Test

Levene Statistic	df1	df2	Sig.
1.844	1	46	0.181

Based on the results of the homogeneity test shown in the table, it can be seen that the significance value of the experimental class is 0.181 > 0.05; therefore, the data in the experimental class is homogeneous. However, because the data is not normally distributed, hypothesis testing is carried out using the Mann-Whitney U test. The Mann-Whitney U test is a non-parametric alternative to the independent sample t test, which is used to examine the difference between two independent groups when the data is measured on an ordinal or interval scale but is not normally distributed. Therefore, this test is appropriate for analyzing differences in students' conceptual understanding abilities between the experimental group and the control group after the application of the Predict-Discuss-Explain-Observe-Discuss-Explain (PDEODE) Learning model.

Table 4. Results of the Non-Parametric Mann–Whitney U Test

	Value
Mann-Whiteney U	193.500
Wilcoxon W	493.500
Z	-1.966
Asymp. Sig. (2-tailed)	0.049

Based on the Mann–Whitney U test, the significance value is 0.049 (< 0.05), indicating a significant difference between the groups (Ho rejected, Ha accepted). Students taught using the PDEODE model showed better conceptual understanding than those in the conventional class. This suggests that active learning through prediction, discussion, observation, and explanation helps students build deeper understanding. In contrast, conventional learning tends to be teacher-centered, limiting students' active involvement and resulting in lower conceptual understanding, as also reflected in the lower average score of the control class compared to the experimental class.

Table 5. Descriptive Statistics of Students' Concept Understanding Test.

Statistic	Experiment Class	Control Class
N	24	24
Minimum	50	35
Maximum	90	85
Mean	68.12	59.79
Standard deviation	13.17	16.45

Based on the table above, the research results are on conceptual understanding. This indicates that the average test score for the experimental class was higher than the average score for the control class. As for the categorization of conceptual understanding assessment (Ministry of Education and Culture of Republic Indonesia, 2014):

Table 6. Conceptual Understanding Category

Range Score	Category
0.00 – 37.50	Poor
37.75 – 62.50	Enough
62.75 – 87.50	Good
87.75 – 100	Very good

Based on the table of average scores for each aspect of conceptual understanding in the experimental class, it can be seen that in the translation indicator, there are 10 students who are in the very good category with a percentage of 42%. In the interpretation indicator, there are 12 students who are in the sufficient category with a percentage of 50%, while the extrapolation indicator, there are 16 students who are in the poor category with a percentage of 67%. Excellent translation scores indicate that translation reflects students' ability to transform or translate information into a more understandable form. In the interpretation indicator, students were able to understand, interpret, and find meaning from the information they received, but needed improvement. Therefore, students with high translation scores typically have a deep understanding of the material, not only receiving the information but also transforming and adapting it into a more understandable form. Meanwhile, in the extrapolation indicator, students' conceptual understanding fell into the poor category. This indicates that the PDEODE model is more effective in improving students' conceptual understanding compared to conventional learning. These findings are consistent with previous studies that have also shown that PDEODE enhances students' active engagement and conceptual understanding. However, unlike earlier studies that generally focused on overall learning outcomes, this study places a more specific emphasis on conceptual understanding, thereby strengthening and clarifying the evidence that the PDEODE model is effective in developing deeper conceptual knowledge.

Based on the table of average scores for each aspect of conceptual understanding in the control class, translation achieved a score of 37%, categorized as good. Interpretation scored 88% in the "poor" category, and extrapolation also fell into the "poor" category, with an average score of around 92%. These findings indicate that students exhibit a strong tendency toward conceptual understanding in the translation

indicator. This indicates that students have adequate ability to translate relationships in figurative forms, calculations, and formulas, and are consistent in converting information from one form to another accurately and meaningfully. The interpretation indicator indicates that students still have difficulty connecting the information obtained to the given situation, resulting in incomplete interpretations and lack of logical reasoning. Meanwhile, the extrapolation indicator indicates that students' ability to draw conclusions and predict events based on available information is still low and has not yet developed optimally. This process of drawing conclusions remains a challenge for students, resulting in difficulties in determining the correct answers to predictions and observations.

These results indicate that the intervention in the experimental class had a significant effect on improving students' conceptual understanding. This is important because misconceptions are still common in the topic of temperature and heat, such as assuming that temperature and heat are the same. Through the PDEODE model, students can test and revise their initial understanding, thereby reducing these misconceptions. Thus, this approach is effective not only in improving understanding but also in addressing conceptual misunderstandings. This improvement is reflected not only in higher grades. This improvement is reflected not only in the higher average scores but also in the consistency of the experimental class, where several students have achieved maximum results. The average conceptual understanding score of students in the experimental class was higher than that of the control class, with improvements observed in all conceptual understanding indicators—Translation, Interpretation, and Extrapolation. This indicates that the Predict – Discuss – Explain – Observe – Discuss – Explain (PDEODE) learning model is effective in improving students' conceptual understanding.

D. Conclusion

There is a statistically significant effect of implementing the Predict–Discuss–Explain–Observe–Discuss–Explain (PDEODE) learning model on students' conceptual understanding of temperature and heat. This is evidenced by the Mann–Whitney U test result with an Asymp. Sig value of 0.049 (≤ 0.05), indicating that H_0 is rejected and Ha is accepted. Scientifically, this finding confirms that a constructivist-based learning approach like PDEODE is effective in facilitating deeper conceptual understanding by actively engaging students in predicting, discussing, observing, and refining their ideas. The higher mean score in the experimental class (68.12) compared to the control class (59.79) further strengthens the conclusion that PDEODE provides a meaningful improvement over conventional learning methods.

However, this study has several limitations that should be considered. First, the sample size is relatively limited, which may affect the generalizability of the findings. Second, the study focuses only on the topic of temperature and heat, so the effectiveness of the PDEODE model on other physics topics remains uncertain. Third,

this research does not examine the long-term impact of the model on students' conceptual understanding, leaving questions about the sustainability of the learning outcomes. Therefore, future studies are recommended to involve larger samples, cover a wider range of topics, and include long-term assessments to provide more comprehensive evidence.

Based on these findings, physics teachers are encouraged to adopt and adapt the PDEODE learning model, particularly for topics that require deep conceptual understanding and active student engagement.

References

Alabdulaziz, M. S. (2022). The effect of using PDEODE teaching strategy supported by the e-learning environment in teaching mathematics for developing the conceptual understanding and problem-solving skills among primary stage students. *Eurasia Journal of Mathematics, Science and Technology Education*, *18*(5), 1–18. https://doi.org/10.29333/ejmste/12019

Asyhari, A., & Harianti, D. (2023). Pengaruh Pembelajaran Integrative Learning (IL) dan Predict, Discus, Explain, Observe, Discuss (PDEODE) terhadap Pemahaman Konsep. *Khazanah Pendidikan Islam*, *2*(1), 1–11. https://doi.org/10.15575/kp.v2i1.8387

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (2001). *A Taxonomy for Learning, Teaching, and Assessing*. Longman.

Chimmalee, B., & Anupan, A. (2024). The Influence of an Interactive Learning Model Based on the PDEODE Strategy with Cloud Technology on Students' Self-Regulation in Mathematics Learning. *International Journal of Information and Education Technology (IJIET)*, *14*(7), 936–944. https://doi.org/10.18178/ijiet.2024.14.7.2120

Gay, S., Sahjat, S., & Hamid, F. (2022). Efektivitas Pembelajaran Fisika Menggunakan Model Pembelajaran Pdeode dan Model PBL Terhadap Hasil Belajar Siswa Kelas VII di SMP Negeri 5 Kota Ternate pada Materi Kalor. *Edukasi (Jurnal Pendidikan Universitas Khairun)*, *20*(1), 112–122. https://doi.org/10.33387/j.edu.v20i1.4484

Isti'anah, Zaini, T. B., & Ilmiati, A. (2024). Implementasi Strategi MINDS untuk Meningkatkan Pemahamn Konsep dalam Pembelajaran Fisika pada Siswa SMP. *Jurnal Pengabdi (Jurnal Pengabdian Masyarakat Berbasis Pesantren dan Madrasah)*, *3*(1), 1–12.

Mailani, T., Zulfarina, & Syafii, W. (2022). *Development of the PDEODE-WEB Model in Blended Learning to Improve the Students Critical Thinking Skills*. *1655*(1), 1–5. https://doi.org/10.1088/1742-6596/1655/1/012054

Marfu'ah, S., Zaenuri, Masrukan, & Walid. (2022). Model Pembelajaran Matematika untuk Meningkatkan Kemampuan Penalaran Matematis Siswa. *Prosiding Seminar Nasional Matematika (PRISMA)*, *5*, 50–54.

Ministry of Education and Culture of Republic Indonesia. (2014). *Penilaian Hasil Belajar oleh Pendidik pada Pendidikan Dasar dan Pendidikan Menengah* (104 Tahun 2014). Kementerian Pendidikan dan Kebudayaan Republik Indonesia.

Samsudin, M. A., Jamali, S. M., Zain, A. N. M., & Ebrahim, N. A. (2020). The Effect of STEM Project Based Learning on Self-Efficacy among High-School Physics Students. *Journal of Turkish Science Education*, *17*(1), 94–108. https://doi.org/10.36681/tused.2020.15

Sarwendah, A., Muhajir, & Sunardjo. (2022). Perbedaan Keterampilan dan Kemampuan Penalaran Formal Siswa Menggunakan Model Pembelajaran PDEODE Berbasis Teaching Factory. *Jurnal Teknologi Pembelajaran Indonesia*, *12*(1), 142–152. https://doi.org/10.23887/jurnal_tp.v12i2.1403

Setiani, N., Roza, Y., & Maimunah. (2022). Analisis Kemampuan Siswa dalam Pemahaman Konsep Matematis Materi Peluang pada Siswa SMP. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *6*(2), 2286–2297. https://doi.org/10.31004/cendekia.v6i2.1476

Siahaan, A., Akmalia, R., Amelia, L., Sitorus, A. A. M., Siraj, M. S., & Ardiansyah, Y. (2025). Mengelola dan Meningkatkan Mutu Pembelajaran Pendidik dan Tenaga Kependidikan dalam Manajemen Lembaga Pendidikan Islam. *Journal on Education*, *5*(3), 5815–5825. https://doi.org/10.31004/joe.v5i3.1344

Sugiyono. (2022). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D* (2nd ed.). Alfabeta.

Zulham, M., Sukmawati, & Yasmin, S. F. (2023). *Keterampilan Berpikir Kritis dalam Pembelajaran Tematik Ditinjau Motivasi Belajar: Strategi PDEODE (Predict Discuss Explain Observe Discuss Explain) dan SGD (Small Group Discussion)*. *3*(1), 9–19. https://doi.org/10.54065/pelita.3.1.2023.317