



Integrated Temperature and Heat Teaching Module for Pancasila Student Profiles to Improve Learning Outcomes

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Article Info	Abstract
Article history: Received: December 24, 2025 Accepted: April 20, 2026 Published: July 25, 2026	Physics learning in the Merdeka Curriculum still faces challenges in achieving 21st-century competencies. In many classrooms, the learning process remains dominated by lectures and formula memorization, limiting students' opportunities to explore concepts, conduct experiments, and develop problem-solving skills. Moreover, the integration of Pancasila Student Profile values—particularly critical thinking, faithfulness and devotion to God Almighty, and collaboration—has not been clearly reflected in the available teaching materials. This gap indicates the need to develop a module that not only presents content but also encourages students to actively construct understanding through a guided inquiry approach. This study developed a heat and temperature learning module designed to address this gap. The development followed the ADDIE model and was tested on 30 high school students in Banjarmasin through expert validation, implementation observations, and learning achievement tests. The findings show that the module meets the criteria of validity, practicality, and effectiveness, with a cognitive N-Gain score of 0.47 (medium category). Thus, this module is feasible to be used as an alternative teaching material that supports more active and contextual physics learning in line with the direction of the Merdeka Curriculum. The implications of this study indicate that the integration of Pancasila Student Profile values into physics teaching modules not only contributes to improving students' conceptual understanding but also provides a foundation for strengthening character development, such as critical reasoning, mutual cooperation, and faith-based attitudes within the learning process. Furthermore, the findings of this study can serve as a reference for teachers and instructional material developers in designing similar learning modules for other physics topics, as well as encouraging schools to implement instructional tools that align with Merdeka Curriculum policies and the reinforcement of 21st-century competencies.
Keywords: Guided inquiry Heat Learning outcomes <i>Pancasila Student Profile</i> Teaching module Temperature	
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INTRODUCTION

Twenty-first-century education requires students not only to master cognitive aspects but also to demonstrate strong character, critical reasoning skills, and readiness to face global challenges (Akbar, 2023; Chu et al., 2016; Handayani et al., 2020; Tan et al., 2017). The Merdeka Curriculum is designed to meet these demands through student-centered learning and the integration of Pancasila Student Profile (P5) values, such as being faithful and devoted to God Almighty, critical thinking, creativity, independence, cooperation, and global diversity (Kemendikbudristek, 2022). However, classroom practices reveal a

significant gap. Physics learning is still dominated by lectures and formula memorization, causing students to show limited development of the expected character indicators. For instance, group work tends to be passive and does not reflect the value of cooperation, and students' appreciation of natural phenomena, which should strengthen the value of faith, is not evident in classroom discussions. This condition is reflected in a preliminary study in class XI-2 of SMA Negeri 4 Banjarmasin, which achieved an average score of only 0.19, consistent with Indonesia's low scientific literacy in the 2018 PISA report ([OECD, 2019](#)).

Previous studies have shown that guided inquiry models are effective in improving scientific reasoning skills and learning outcomes ([Batubara, 2021](#); [Zaini, 2015](#)), while context-based modules have been proven to strengthen conceptual understanding ([Rahmat et al., 2023](#)). However, these studies have not systematically integrated P5 character development into teaching modules. Moreover, most available physics modules still focus primarily on material presentation and routine exercises, with less engaging visual design, contexts that are not sufficiently relevant to students' daily lives, and pedagogical approaches that do not adequately promote collaboration or value reflection. As a result, existing modules have not fully supported the Merdeka Curriculum's expectation for active, contextual, and character-building learning.

To address this gap, a temperature and heat teaching module is needed that not only employs a guided inquiry model but also integrates core Pancasila Student Profile values, faith and devotion through appreciation of natural phenomena, critical reasoning through experiment analysis, and cooperation through group investigations. This module is expected to improve learning outcomes while shaping students' character in alignment with the Merdeka Curriculum. Therefore, this study aims to develop a temperature and heat teaching module integrated with P5 values using a guided inquiry model that is valid, practical, and effective for improving students' physics learning outcomes.

METHODS

This study employed a research and development (R&D) design using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), referring to the latest developments by [Branch](#) (2018) and widely applied in instructional material development research over the past five years. The ADDIE model was chosen for its systematic and flexible nature, as well as its capacity to support continuous evaluation at each development stage. The research subjects consisted of 30 students from class XI-2 of SMA Negeri 4 Banjarmasin in the 2024/2025 academic year, selected purposively based on a preliminary study indicating low learning outcomes in the topic of heat and temperature.

The novelty of this research lies in the integration of Pancasila Student Profile (P5) values into the heat and temperature teaching module, particularly the values of cooperation, critical thinking, independence, and being faithful and devoted to God Almighty. To ensure that these character values were properly measured, the study employed a character observation sheet developed based on the operational indicators of P5 established by the Ministry of Education, Culture, Research, and Technology (2021–2023). This observation sheet includes observable behavioral indicators such as participation in group work, persistence in solving problems, self-reflection, and spiritual attitudes when relating physics phenomena to religious values. The observation scores were analyzed descriptively to examine the development of students' character values.

The validators consisted of two physics education lecturers and two high school physics teachers. The research instruments included validation sheets (for content, lesson plans, worksheets, and module design) developed based on the latest standards for learning device validity ([Widoyoko, 2020](#)). An implementation sheet was used to assess practicality, completed by observers during the implementation process. Learning achievement tests, consisting of a pretest and a posttest, were used to measure the module's effectiveness. Content validity was assessed by experts, while reliability was calculated using Cronbach's

alpha with a minimum reliability criterion of $r \geq 0.70$ as the acceptable threshold (Tavakol & Dennick, 2013).

Data were analyzed using expert-based validation with a four-point Likert scale to determine content validity, as commonly applied in recent physics education research. Module practicality was evaluated through the percentage of lesson implementation, reflecting the ease of use and feasibility in classroom settings (Sefrina et al., 2024). Furthermore, module effectiveness was measured using the normalized gain (N-Gain), which remains a widely accepted indicator for assessing learning improvement in physics education studies (Bao & Koenig, 2024; Elvanisi et al., 2025). The research procedure followed the ADDIE stages:

- Analysis: analysis of needs, curriculum, learner characteristics, and instructional materials.
- Design: development of the module design, validation instruments, and learning achievement tests.
- Development: creation of the heat and temperature module integrated with P5 using guided inquiry, followed by expert validation.
- Implementation: limited trial with class XI-2 students.
- Evaluation: evaluation of validity, practicality, effectiveness, and character value development to determine the module's feasibility.

The average scores of the validation instruments were calculated using standard formulas and compared with the module validity in Table 1. Furthermore, the reliability of the validation results from the three experts was analyzed using Cronbach's alpha and categorized according to the reliability. The practicality of the module was assessed using the implementation sheet that had been developed. The average observation score was then interpreted according to the relevant module practicality criteria.

RESULTS AND DISCUSSION

The temperature and heat learning module integrated with the Pancasila Student Profile and employing the guided inquiry model was validated by three experts, consisting of two physics education lecturers from FKIP ULM and one physics teacher from SMA Negeri 4 Banjarmasin. The validation covered aspects of content feasibility, presentation, language, and pedagogical components. Revisions to the module were made based on the validators' suggestions, and the assessment results were calculated to obtain the average score and reliability. The following is the cover of the temperature and heat module, which can be seen in Figure 1.

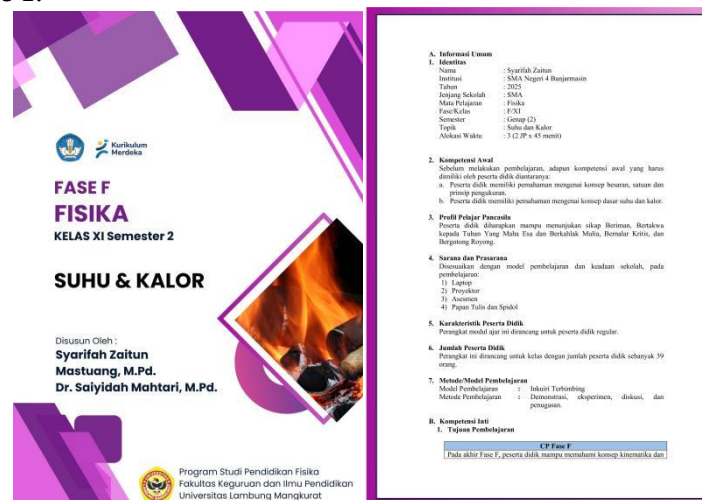


Figure 1 Integrated teaching module of the Pancasila student profile

Validity of Teaching Modules

The validity assessment of the teaching module conducted by three validators was calculated for its average value and reliability. The results of the validity and reliability calculations for the teaching module are as shown in Table 1.

Table 1 Results of validation and reliability of teaching modules

Aspect Evaluation	Validity		Reliability	
	Mark	Category	Mark	Category
General information	3.91	VV	0.99	Reliable
Core components	3.69	VV		
Attachment details	3.64	VV		
Glossary	3.33	V		
Bibliography	2.67	CV		
Average	3.45	VV		

Information: VV = Very Valid, V= Valid, QV=Quite Valid

The validation results in Table 1 show that the module obtained an average validity score of 3.45 (categorized as very valid) and a reliability coefficient of 0.99 (categorized as reliable). Based on Table 1, the very high reliability value indicates that the assessments among validators have excellent consistency, making the validation results trustworthy. This suggests that each component of the module was evaluated in a stable manner without significant differences among the raters. Therefore, the developed teaching module not only meets the criteria of content and construct validity but also demonstrates a high level of reliability for use in learning. The results of the validation calculation of the learning outcome test are presented in Table 2.

Table 2 Results of validation of learning outcome tests

Assessment Aspects	Validity		Reliability	
	Average	Category	Average	Category
Instructions for using the questions are clearly stated.	4.00	VV	0.75	Reliable
Questions are in accordance with learning objectives.	3.60	VV		
Clear scoring guidelines	3.60	VV		
Matching scores	3.60	VV		
The question sentence does not give rise to multiple interpretations	4.00	VV		
Questions use clear questions or commands.	4.00	VV		
The time for completing the questions is appropriate	4.00	VV		
Using correct Indonesian language rules	4.00	VV		
Using easy-to-understand language	4.00	VV		
Questions are suitable for measuring students' level of critical thinking.	4.00	VV		
Average	3.88	VV		

Information: VV = Very Valid

These results indicate that the overall content of the module meets the standards of learning material feasibility. However, the reference list component received a “fairly valid” category, suggesting that improvements are needed in terms of completeness and the currency of sources. The teaching materials are proven to meet the indicators, conceptually correct, supplemented with practice questions, illustrations, PUEBI language, and support independent learning ([Meliana et al., 2022](#); [Prastowo, 2015](#)). The student worksheets is prepared with clear instructions, language appropriate to the student's level, and questions that support the achievement of learning objectives ([Nurhasanah et al., 2022](#)) which

emphasize that the quality of references and conceptual accuracy significantly influence module feasibility.

Based on Table 2, the average value of the validity of the learning outcome test was 3.88 with a very valid category and reliability of 0.75 with a reliable category. The temperature and heat teaching module was developed by integrating the Pancasila Student Profile and applying a guided inquiry model. The module is prepared in hard-copy format so that teachers can use it directly in the classroom. A module is considered feasible if it meets the criteria of validity and reliability. Recent studies on the development of physics teaching modules indicate that modules deemed valid based on expert evaluations and meeting reliability criteria can be effectively used in physics learning ([Aldilla & Usmeldi, 2024](#); [Hasanah et al., 2025](#); [Shaliha et al., 2024](#); [Sukma et al., 2025](#)). In addition, the analysis of valid and reliable physics assessment instruments ensures the accuracy of measuring students' abilities in physics learning. The results of the validity test show that the module is classified as very valid with an average score of 3.45. The assessment covers five aspects: (1) general information (title, educational phase, description, time allocation, learning model, facilities); (2) core components (achievements, objectives, trigger questions, inquiry syntax, assessment, students' worksheet); (3) appendices (relevant reading materials and students' worksheet); (4) glossary (terms supporting understanding); and (5) bibliography (quite valid, needs to be improved).

The module's reliability reached 89.37%, indicating high consistency, making the module trustworthy. The learning achievement test instrument also demonstrated strong quality, with a validity score of 3.88 (very valid) and reliability of 0.75. This reinforces the finding that the assessment tool is appropriate for measuring critical thinking skills, as recommended in recent physics assessment research ([Lina & Desnita, 2022](#); [Puspitasari et al., 2022](#); [Rizalia et al., 2021](#)).

Practicality of Teaching Modules

The results of the learning implementation test indicate that the teaching module is considered practical, with the implementation percentage reaching the "good" category. This means that the module can be used easily by teachers and students and is in accordance with the plan. The results of the calculation of the implementation of the teaching module are listed in Table 3.

Table 3 Results of calculating the implementation of the teaching module

Activity		Meeting 1		Meeting 2		Meeting 3	
		Average	Category	Average	Category	Average	Category
Introduction (Problem orientation)		4.00	VP	3.83	VP	3.72	P
Core activities	Formulating a hypothesis	3.89	VP	3.83	VP	4.00	S P
	Collecting data	3.83	VP	3.83	VP	4.00	S P
	Analyzing data	2.50	QP	3.33	P	4.00	S P
	Draw a conclusion	2.50	QP	3.00	P	2.67	CP
Closing		3.50	VP	3.50	VP	3.75	S P
Average		3.37	VP	3.56	VP	3.69	S P
Reliability		0.98	Reliable	0.97	Reliable	0.98	Reliable
Overall average		3.54					
Category		Very Practical					

Information: VP=Very Practical, QP= Quite Practical

The practicality test results indicate an average implementation score of 3.54 (categorized as *very practical*). The module was easy for teachers and students to use, the

guided inquiry syntax could be consistently applied, and each activity aligned with the instructional plan. These findings are consistent with research from the past five years ([Atika et al., 2022](#); [Darllis et al., 2020](#)), which reports that inquiry-based modules generally achieve high practicality because they provide structured experimental steps.

The data analysis phase improved from quite good in the first meeting to very good in the third meeting, indicating student adaptation in processing data. However, the conclusion-drawing phase was still in the quite good category, so the ability to conclude data needs to be strengthened. In the closing phase, the score was stable in the very good category. Overall, the module was deemed practical because it was easy to use, consistent, and aligned with the learning design. This supports [Rizqiyani et al. \(2022\)](#) opinion that a practical module is not only easy to use but also relevant to classroom conditions. Nevertheless, certain activities showed lower results, especially the “drawing conclusions” component, which only reached the *fairly practical* category in two meetings. This issue arose due to the lack of explicit examples of how to synthesize experimental data within the module, as well as students’ limited experience in making scientific generalizations—a finding also reported by [Pramesti et al. \(2020\)](#) and [Sefrina et al. \(2023\)](#). Therefore, necessary improvements include adding scaffolding in the form of example conclusions, higher-order guiding questions, and analytic rubrics for interpreting data.

Effectiveness of Teaching Modules

The effectiveness of the module was demonstrated through improved student learning outcomes. The N-Gain value of 0.47 was obtained from the comparison of the pretest and posttest, which is categorized as “moderate.” This finding indicates that the module is effective in improving the understanding of temperature and heat concepts in grade XI-2 students of SMA Negeri 4 Banjarmasin.

Table 4 Results of N-gain cognitive learning outcomes

Pre-test average		Post-test average		N-gain	
Mark	Category	Mark	Category	Mark	Category
2.07	Low	47.80	Currently	0.47	Currently

The N-Gain analysis score of 0.47 places the module’s effectiveness in the moderate category. Although there was an improvement from the pretest score of 2.07 to the posttest score of 47.80, the final score remained below the minimum mastery criterion. Therefore, the claim of the module’s effectiveness needs to be moderated, as the observed improvement does not yet indicate high learning outcomes. Thus, the module is more appropriately described as fairly effective or as having potential effectiveness, rather than being optimally effective.

To strengthen this finding, inferential statistical analysis is required, such as a paired sample t-test or a nonparametric test (e.g., Wilcoxon), to ensure that the improvement in learning outcomes is statistically significant rather than merely a descriptive difference. Without inferential analysis, conclusions regarding effectiveness remain limited to descriptive interpretation. Several factors contributed to the suboptimal effectiveness, including:

- Low ability in drawing conclusions, as reflected in the practicality results; this hindered the full implementation of inquiry-based learning ([Elvanisi et al., 2025](#)).
- Limited instructional time, as also reported in previous studies ([Sari et al., 2021](#)), which note that inquiry processes require more time than expository methods.
- Low prior knowledge of students, as indicated by the pretest score of 2.07, meaning that more practice cycles are needed to achieve significant improvement ([Bao, 2020](#)).

Despite being in the moderate category, the module still contributes to the development of scientific thinking skills, particularly through worksheets that guide students in observing, collecting data, analyzing, and drawing conclusions. The integration of

Pancasila Student Profile values—such as collaboration, independence, critical thinking, and faith—also enhances student engagement in group work and reflection on natural phenomena as part of character development ([Nurhasanah et al., 2022](#); [Yuliani et al., 2023](#)). Relationship Between Validity, Practicality, and Effectiveness. The results of the study indicate that:

- High validity → the module content is accurate and aligned with learning objectives.
- Very high practicality → the module can be used by teachers and students without significant difficulties.
- Moderate effectiveness → learning outcomes improved but have not yet reached an optimal level.

The gap between validity–practicality–effectiveness indicates that theoretical feasibility does not automatically guarantee high learning outcomes. Based on the results in the previous tables, although the module demonstrates very high validity (3.45), very strong reliability (0.99), and very good practicality (3.54), its effectiveness remains at a moderate level (N-Gain 0.47). This condition is caused by weaknesses in the implementation of the inquiry syntax, particularly in the “drawing conclusions” activity, which consistently received lower scores compared to other activities. The development of results across each meeting shows improvement, especially in the data analysis aspect, which increased from fairly practical to very practical. This indicates that students began to adapt to the inquiry process. However, this improvement was not followed optimally by their ability to draw conclusions, which consequently affected the overall learning outcomes.

Compared to other studies, a moderate N-Gain result is a common finding in the initial implementation of the inquiry model, especially among students with low prior knowledge ([Khairunnisa et al., 2020](#); [Bao, 2020](#)). However, this study provides an additional finding that the limitation in effectiveness is not only influenced by students’ initial abilities but is also directly related to the quality of implementation at each stage of inquiry within the module. These findings reinforce previous studies stating that the effectiveness of inquiry-based learning is strongly influenced by the quality of teacher facilitation and students’ readiness to carry out scientific processes ([Khairunnisa et al., 2020](#); [Sefrina et al., 2023](#)). Therefore, the main contribution of this study lies in analyzing the relationship between validity, practicality, and effectiveness, as well as identifying specific stages of inquiry that act as limiting factors, thereby providing clearer directions for future module improvement.

Limitations of the Study

- The trial was conducted only in one class (30 students), limiting the generalizability of the results.
- Effectiveness was measured only in the cognitive domain and did not quantitatively assess Pancasila Student Profile character values.
- No comparison with other learning models was conducted, so relative effectiveness could not be fully determined.

CONCLUSION

Based on the results of the research and discussion, it can be concluded that the temperature and heat teaching module integrated with the Pancasila Student Profile using a guided inquiry model meets the criteria of validity, practicality, and effectiveness. The module was declared valid based on expert assessments of the lesson plans, materials, and student worksheets, which showed a very valid category. The practicality of the module is reflected in the good implementation of learning during the implementation stage. This module has also been proven effective in improving student learning outcomes, with an N-Gain score of 0.47, which falls into the moderate category.

The implication of this study is that a teaching module integrated with the values of the Pancasila Student Profile can serve as an alternative learning tool that not only improves cognitive learning outcomes but also instills character values such as critical reasoning,

cooperation, and faith in God Almighty. This module can be used as a reference by physics teachers in implementing active learning aligned with the Merdeka Curriculum.

In addition to opening opportunities for more comprehensive further development, this study also has several limitations that need to be considered. The study examined the effectiveness of the module in only one class with a limited number of participants; therefore, the findings cannot yet be generalized widely. Moreover, the effectiveness of the module was still focused on the cognitive domain, while affective aspects and the development of Pancasila Student Profile character values were not analyzed quantitatively. Therefore, future studies need to assess affective and character dimensions to determine the extent to which the module truly contributes to the measurable formation of Pancasila Student Profile values, for example, through attitude observation instruments, reflection journals, or peer assessment.

Furthermore, comparisons with other learning models—such as problem-based learning, discovery learning, or cooperative learning—should be conducted to identify the most effective model for supporting inquiry skills and improving student learning outcomes on the topic of temperature and heat. Cross-school trials involving schools with different characteristics (e.g., urban–rural, public–private, or schools with varying laboratory facilities) are also important to test the generalizability of the module. Thus, the developed teaching module will not only be stronger from an empirical perspective but will also have greater potential to serve as a sustainable, adaptive, and relevant learning tool for strengthening 21st-century competencies across diverse educational settings.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

SZ was responsible for the research conceptualization, development of the teaching module, data collection, data analysis, and manuscript writing. MM contributed to research design validation, data interpretation, and critical revision of the manuscript. SM reviewed the learning instruments, provided methodological guidance, and approved the final version of the manuscript.

AI DISCLOSURE STATEMENT

The authors used generative artificial intelligence to assist in improving the clarity, grammar, and academic language of the manuscript, as well as to enhance sentence structure and readability. The AI tool was not used to generate research data, perform data analysis, interpret findings, or draw scientific conclusions. All scientific content, study design, data interpretation, and final manuscript revisions were conducted and verified by the authors. The authors take full responsibility for the accuracy, integrity, and originality of the manuscript.

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