



The Effectiveness of Temperature and Heat Module Through P2F to Improve Science and Numeracy Literacy

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Abstract: *This study aims to enhance students skills in science literacy and numeracy by creating temperature and heat modules using the learning of physics modeling at least in the effective category. This module is designed as a learning innovation because students frequently struggle to grasp the concepts of temperature and heat conventional methods. This study used the ADDIE development model and Research and Development (R&D) research methods to conduct trials on 35 grade XI students from high schools in Banjarmasin. The ADDIE model was chosen because it has clear stages for needs analysis, design, development, implementation, and evaluation, allowing the resulting modules to be systematically tested. The trial was carried out using a one-group pre-test post-test design. Data was collected through the (THB), which has been adjusted to numeracy and science literacy indicators. The results showed that this module was effective, with an n-gain score of 0.74, which shows how much students' skills improved after using it. Therefore, the temperature and heat modules learned through physics modeling can be used to improve students' numeracy and literacy skills. They can also be used as an innovative alternative learning resource in high school.*

Keywords: *physics modeling instruction, science and numeracy literacy, temperature and heat*

Efektivitas Modul Suhu dan Kalor Melalui P2F untuk Meningkatkan Literasi Sains dan Numerasi

Abstrak: Penelitian ini bertujuan untuk meningkatkan keterampilan siswa dalam literasi sains dan numerasi dengan membuat modul suhu dan panas menggunakan pembelajaran pemodelan fisika setidaknya dalam kategori efektif. Modul ini dirancang sebagai inovasi pembelajaran karena siswa sering mengalami kesulitan memahami konsep suhu dan kalor dengan metode konvensional. Studi ini menggunakan model pengembangan ADDIE dan metode penelitian Research and Development (R&D) untuk melakukan uji coba pada 35 siswa kelas XI dari sekolah menengah atas di Banjarmasin. Model ADDIE dipilih karena memiliki tahapan yang jelas untuk analisis kebutuhan, perancangan, pengembangan, implementasi, dan evaluasi, yang memungkinkan modul yang dihasilkan diuji secara sistematis. Uji coba dilakukan menggunakan desain one-group pre-test post-test. Data dikumpulkan melalui (THB), yang telah disesuaikan dengan indikator literasi numerasi dan sains. Hasil penelitian menunjukkan bahwa modul ini efektif, dengan skor n-gain sebesar 0,74, yang menunjukkan seberapa besar keterampilan siswa meningkat setelah menggunakannya. Oleh karena itu, modul suhu dan kalor yang dipelajari melalui pemodelan fisika dapat digunakan untuk meningkatkan keterampilan numerasi dan literasi siswa. Mereka juga dapat digunakan sebagai sumber belajar alternatif yang inovatif di sekolah menengah.

Kata kunci: literasi sains dan numerasi, pembelajaran pemodelan fisika, suhu dan kalor

INTRODUCTION

Education in the modern era requires students are expected not only to comprehend the material but also be come able to think critically, solve problems, work in a team, and have good numeracy skills (Arifin & Mu'id, 2024). Creativity, critical thinking, communication, and collaboration are among the 21st century abilities (Dewantara, 2021). To enable students to meet global problems, education should therefore concentrate on raising the caliber of learning processes and results.

However, research shows that Indonesian students are still lacking in science and numeracy literacy. Where the results of the 2022 PISA survey, which was released on December 5, 2023, found that Indonesia was ranked 68th out of 81 countries. The average score was 379 in math, 398 in science, and 371 in reading. So that Indonesia is far below the international average score of 490 (Al-amin et al., 2024). This condition shows that science and numeracy concepts are not yet being effectively applied by the students to real-world problems, especially in solving problems and analyzing scientific phenomena in a rational way (Suanto, 2024).

Referring to the data collected from physics teacher interviews in grades XI-A2 at SMAN 2 Banjarmasin, the researcher obtained information that most pupils are not used to dealing with problems that measure science and numeracy literacy. This is because the teaching materials used are still general and have not been directly associated with the context or phenomenon that is close to students' lives. Similar findings were also reported in a study by Ate & Ledo (2024), which stated that 73.3% of students were classified as very poor in solving science and numeracy literacy problems, while another 26.7% were in the poor category.

Through the Independent Curriculum, the Indonesian government is trying to answer this challenge by integrating science and numeracy literacy in learning and assessment, among them is through the Minimum Competency Assessment (AKM) since 2021 (Kusumah & Alawiyah, 2021). In addition, module-based learning is also encouraged so that teachers have systematic and contextual teaching guidelines (Maulida, 2022). A good module should be able to help students master concepts through an active and contextual approach.

Learning physics modeling can be a part of the strategies to improve students' science and numeracy literacy. Physics modeling is an approach that invites students to observe phenomena, create visual models (drawings or schemas), formulate mathematical relationships, and test them through simple experiments (Salam & Arifuddin, 2018). Students gain the capacity to apply abstract ideas to real situations.

However, the development of learning modules that integrate physics modeling approaches is still relatively minimal, especially on the topic of temperature and heat which is actually very relevant to the context of daily life. The findings at SMAN 2 Banjarmasin show that learning is still dominated by conventional methods, due to the limited learning resources that support the modeling approach. This condition is one of the factors that cause the increase in science and numeracy literacy among students is not optimal.

Based on these conditions, the development of temperature and heat modules that adopt the physics modeling learning approach is seen as the right solution to overcome existing problems. This module is intended to assist students in grasping concepts in depth, foster scientific thinking, and hone their skills in processing and interpreting data related to physical phenomena. A number of previous studies have proven the effectiveness of modules in improving science literacy (Maryam et al., 2023) and numeracy (Cahyadi et al, 2023), so it is believed that these modules have the potential to significantly aid in elevating the standard of physics learning.

The innovative novelty aspect of this research focuses on the design and use of temperature and heat modules through learning physics modeling with strengthening science and numeracy literacy skills. The modules developed not only convey physics concepts, but are also designed to encourage students to observe phenomena, create models, analyze data, and draw conclusions based on numbers and graphs. In addition, the novelty aspect can also be seen from the use of science and numeracy literacy indicators that are measured with pre-arranged questions rarely applied in detail to temperature and heat materials at the high school level.

THEORY

Physics Modeling Learning

In physics modeling, phenomena are expressed, modeled in the form of images, predictive formulas are made, and then tested through simple experiments and experiments (Salam & Arifuddin, 2018). Physics modeling (P2F) learning is a learning method in which physical events are modeled through image models based on those events. Then, the prediction formula is made based on previously known physical principles using a mathematical model of the phenomenon (Arifuddin et al., 2022).

Studies in the physics model focus on the facts and conditions associated with a physical phenomenon. This study process is based on prerequisite knowledge, namely the basic principles of physics that have been understood before, as well as the relationship between the facts and conditions of the phenomena being studied (Arifuddin et al., 2022). The P2F model is structured in five stages, including : (1) submitting and identifying problems from physical phenomena, (2) conveying relevant prerequisite information, (3) conducting physics modeling, (4) finding solutions, and (5) evaluating the processes and results obtained.

In this model, students learn from theory as well as the real facts and conditions of a physical event. Learning begins with the presentation of problems or phenomena, then students are given the necessary initial knowledge. Next, they create a physics model to explain phenomena, find solutions to problems, and finally evaluate processes and joint outcomes. The P2F model helps students think scientifically with purposeful, fact-based measures.

Science Literacy Skills

Science literacy refers to the ability to understand, explain, and utilize scientific knowledge to solve problems, broaden perspectives, and play a role in preserving the environment (Dewantari & Singgih, 2020). In the framework of science literacy, learners are anticipated to have the ability to address problems and make decisions in daily life by utilizing science knowledge (Muzijah et al., 2020).

Table 1. Science Literacy Indicators (Adaptation OECD, 2023)

Competence	Indicator
Explaining Scientific Phenomena	<ol style="list-style-type: none"> 1. Use scientific knowledge in a particular circumstance 2. Explain or analyze events and forecast shifts 3. Determine the proper explanations, predictions, and descriptions
Evaluate and Design Scientific Investigations	<ol style="list-style-type: none"> 1. Evaluating and exploring a problem 2. Explain and use the methods used by scientists to determine the objectivity of the data
Interpreting Scientific Data and Evidence	<ol style="list-style-type: none"> 1. Convert data from one type to another 2. Analyze and predict data

Numeracy Skills

Based on the Ministry of Education and Culture, numeracy competence refers to the capacity to use numbers and carry out calculations in everyday life, along with the skills to analyze, interpret quantitative data, and solve problems related to quantity, patterns, and numerical information from the surrounding environment.

Table 2. Numeracy Indicators (Adaptation Winata & Cacik, 2021)

No	Indicator
1	Capable of applying diverse numerical forms or mathematical symbols to address real-life problems.
2	Capable of interpreting data presented through multiple formats such as graphs, tables, charts, or diagrams.
3	Draw conclusions from the analysis to make informed predictions and decisions.

METHOD

Types of Research

In the study employs an R&D (Research and Development) model was applied to develop temperature and heat modules through P2F. This research was conducted to develop students' science literacy and numeracy skills (Sari et al., 2023).

Development Model

The stages in the ADDIE framework begin by looking at what learning needs need to be met. After that, the learning steps are designed regularly and clearly. Then, a ready-to-use product or module is made. This product is then tried directly in real situations. After use, evaluation and improvement are carried out based on feedback from users. This ADDIE model provides a structured guide for creating and structuring learning experiences, so it is very suitable for use in module development, as was done in this study.

The researcher conducted a review of field products, curriculum, materials, and student characteristics with 35 students in grade XI-A2 of SMAN 2 Banjarmasin. Interviews with physics teachers revealed low science and numeracy literacy, as students were rarely given literacy-related questions, while curriculum analysis confirmed that temperature and heat topics were taught according to schedule. In the design phase, the researcher created a conceptual framework for the final product, examined learning outcomes, formulated learning objectives, and determined suitable learning resources and techniques, with printed modules designed using P2F.

This study produced a P2F-based temperature and heat learning module to enhance science and numeracy literacy, validated by three experts the instrument obtained an average score of 3.52, indicating very high validity, with a reliability of 86.42% then revised according to validator feedback. The validated modules were implemented in three face-to-face meetings with class XI-A2, assessed by three observers using observation sheets, resulting in an average practicality score of 3.82 (very practical), showing the modules' usefulness and appropriateness for classroom teaching. Evaluation was carried out formatively during the study with necessary adjustments, and summatively after product testing to measure the effectiveness of the modules and the achievement of the objectives in improving students' science and numeracy literacy skills.

Subjects and Objects of Research

This research involves temperature and heat modules as research subjects. The trial is focused on 35 students in grades XI-A2 of SMAN 2 Banjarmasin for the 2024/2025 school

year. This research is focused on testing the effectiveness of temperature and heat modules through P2F in an effort to improve students' science literacy and numeracy skills.

Place and Time of Research

The implementation of this research took place at SMAN 2 Banjarmasin which is located at Jl. Mulawarman No.21, Teluk Dalam, Central Banjarmasin District, Banjarmasin City, South Kalimantan. The research time is from June 2024 to April 2025.

Product Trial Design

It is hoped that this research can improve students' science and numeracy literacy skills, namely by comparing the conditions before and after using the temperature and heat module through P2F (Mulyani et al., 2023).

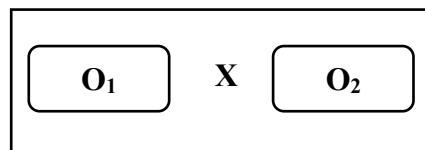


Figure 1. One Group Pre-test Post-test Design

Information:

- O₁ = Learning outcomes to assess students' science and numeracy literacy skills before starting the use of the temperature and heat module developed by the researcher (pre-test)
- O₂ = Learning outcomes to assess students' science and numeracy literacy skills after using the temperature and heat module developed by the researcher (post-test)
- X = Learning using modules

The modules' effectiveness was evaluated through an analysis and comparison of learning outcomes test results from O₁ and O₂. The calculation of effectiveness used the n-gain score formula, with the categories presented in Table 3 to determine the level of improvement.

Effectiveness Assessment Instrument

The Learning Outcome Test (THB) is a research tool for effectiveness. It is used to assess how effective the module is created. Researchers developed this instrument, which consists of seven temperature and heat test questions that measure science and numeracy literacy skills.

Effectiveness Test

The module's effectiveness is evaluated based on (THB) given before and after learning, consisting of seven questions to determine the development of students' abilities after using the developed modules.

The data from the THB obtained was calculated using a normalized gain score (Anjani et al., 2022). The calculation is presented in equation (1).

$$\langle g \rangle = \frac{(\% \{S_f\} - \% \{S_i\})}{(100\% - \% \{S_i\})} \quad (1)$$

Information:

- $\langle g \rangle$ = The average normalized gain
- $\{S_f\}$ = Average post-test score in class
- $\{S_i\}$ = Average pre-test score in class

Then, the results of the calculation are adjusted to the following Table 3.

Table 3. N-gain Category (Hake, 2022)

No	Value <g>	Category
1	$(<g>) \geq 0.7$	Tall
2	$0.7 > (<g>) \geq 0.3$	Keep
3	$(<g>) < 0.3$	Low

THB results data were then calculated using the following equation (2) (Arikunto, 2006).

$$N = \frac{\text{Number of scores obtained}}{\text{Maximum number of scores}} \times 100 \quad (2)$$

Information:

N = the score obtained by the student

Then, the scores obtained on each science and numeracy literacy indicator were leveled and the results were adjusted to Table 4.

Table 4. Science and Numeracy Literacy Skills Category (Qomariyah & Subekti, 2021)

No	Value	Category
1	$80 < N \leq 100$	Very high
2	$60 < N \leq 80$	Tall
3	$40 < N \leq 60$	Quite tall
4	$20 < N \leq 40$	Low
5	$N \leq 20$	Very low

RESULTS AND DISCUSSION

Result

Classes XI-A2 of SMAN 2 Banjarmasin totaled 39 students but only 35 students were counted in this study. The pre-test will be held on April 16, 2025, while the post-test will be held on April 24, 2025. The results of the calculation of the effectiveness of the modules are shown by the following Table 5.

Table 5. Results of Module Effectiveness Calculation

Pre-test Average	Post-test Average	N-gain	Category
8.74	76.51	0.74	High/effective

Table 5 shows that students' average pre-test scores are still very low, reflecting weak science and numeracy literacy skills. In contrast, the average post-test score is in the good category, indicating improvement. This increase is supported by high or effective N-gain values. Based on these findings, the modules developed were declared effective in supporting learning and improving student literacy.

Table 6. Achievement of Science Literacy Skills

No	Science Literacy Indicators	Average Pre-test		Post-test average	
		Value	Category	Value	Category
1	Average aspects of applying science knowledge	32.57	Very low	86.00	Very high
2	The average aspect of describing or interpreting a phenomenon	10.57	Very low	70.29	Tall
3	Average aspects identify description, explanation, prediction	16.00	Very low	77.33	Tall
4	Average aspect of data conferencing	10.67	Very low	86.48	Very High
5	Average aspects of analyzing and predicting data	0.86	Very low	88.86	Very High
6	Average aspects of evaluating and exploring	0.86	Very low	73.29	Tall
7	Average aspects of explaining and using the scientist's method	0.86	Very low	63.86	Tall

Table 6 shows that students' science literacy skills were in the very low category in the pre-test. In contrast, the post-test results show very high achievement in all aspects, including applying science knowledge, condensing, analyzing, and predicting data, as well as describing or interpreting phenomena, identifying descriptions, plans, and predictions, and evaluating and exploring phenomena.

Table 7. Achievement of Numeracy Skills

No	Numeracy Indicators	Average Pre-test		Average Post-test	
		Value	Category	Value	Category
1	Average aspect using various numbers/symbols	24.29	Very low	81.67	Very High
2	Average analysis aspect of various forms	5.76	Very low	87.67	Very High
3	Average aspect of interpreting the results of the analysis	4.10	Very low	69.14	Tall

The Table 7 shows students' numeracy skills are very low in pre-tests, but they increase very high in post-tests, especially in assessing various forms as well as applying numerical ranges and symbolic representations.

The temperature and heat module is designed using the P2F model syntax. This model is composed of five stages, which are: (1) formulating and identifying problems based on physical phenomena, (2) presenting prerequisite information, (3) conducting physics modeling activities, (4) finding and formulating solutions, and (5) evaluating learning processes and outcomes.



MEETING 1 : TEMPERATURE AND EXPANSION


After studying this subchapter material, you are expected to be able to:

1. Students are able to analyze the influence of temperature on the expansion of various substances in physical phenomena or problems
2. Students are able to calculate the expansion coefficient of an object in a physical phenomenon or problem

PHASE 1 : SUBMISSION AND IDENTIFICATION OF PROBLEMS OF PHYSICAL PHENOMENA

In our dally lives, we often use water and oil as part of various activities, such as cooking or mixing ingredients in a solution. Water is used for various purposes, from boiling, washing, to as the main ingredient in drinks. Meanwhile, oil is widely used in the cooking process, such as frying or sautéing food. If oil and water are heated in 2 different containers at the same time, which one will heat up faster? What measuring instrument is suitable for measuring the temperature of the oil and water? At what temperature will oil and water heat or boil? What happens to the volume of oil and water when heated?




Watch the following video to better understand the

Figure 1. Water and oil when heated
Source : personal documentation


Figure 2. Phase 1 Submission and Identification of Physical Phenomena Problems

In In Figure 2 phase 1, the teacher proposes physical phenomena such as heating water and oil, melting butter and ice, and bonfires. This phase is important as a starting point to foster students' curiosity and activeness, as well as train them to observe, identify variables, and think scientifically. This stage also becomes the basis for science literacy and numeracy abilities developed through the application of observing, analyzing, modeling physical phenomena contextually.



Let's identify the observed physical phenomena!

The more you write down a phenomenon, it shows that you have science literacy skills in **explaining scientific phenomena** (Identifying appropriate descriptions, explanations, and predictions)




Let's make scientific questions that are relevant/in accordance with observed physical phenomena!

Figure 3. Identification of Scientific Phenomena in Phase 1

In In Figure 3 phase 1, the teacher starts the meeting by presenting a physical phenomenon, then students are asked to identify the phenomenon and formulate relevant scientific questions. This stage trains literacy in the competence of explaining scientific phenomena through proper description, explanation, and prediction. This phase is important as it stimulates students to think critically, engage actively in scientific processes, and develop curiosity, analytical abilities, and contextual understanding within modeling-based science learning.

PHASE 2 : PROVISION OF INFORMATION/PREREQUISITE




Prerequisite Information

1. Heat (Q) is defined as the energy that moves from a higher temperature to a lower temperature when the two objects come into contact.
2. The SI unit of heat is Joule and in CGS is erg. 1 Joule = 107 erg. Before knowing that heat is a form of energy, the unit of heat was first given the name of calories (abbreviated cal, in lowercase letters). 1 calorie = 4.18 joules or 1 Joule = 0.24 cal.

Figure 4. Phase 2 Provision of Prerequisite Information/Knowledge

In Figure 4 phase 2, students read the module material as prerequisite information to understand the physics concepts to be studied. This phase is important as a conceptual foundation before the modeling stage, because through discussion and reading of the modules students gain the initial understanding necessary to interpret phenomena scientifically. The presentation of prerequisite information also builds a strong frame of mind, so that students are better prepared to analyze, connect concepts, and develop physics models at the next stage.

PHASE 3 : PHYSICS MODELING



Physical Modeling in Picture Form

Based on the phenomenon in figure 3, the process of change of form can be modeled in the form of a physical image. Complete the following 4 pictures! if you can properly complete the picture it shows that you have science literacy skills in explaining scientific phenomena (Describing or interpreting phenomena and predicting changes)

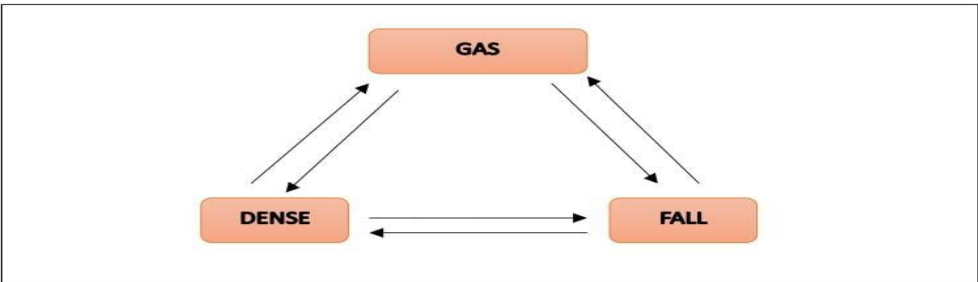



Figure 5. Physics Modeling in Image Form in Phase 3

In Figure 5 phase 3, students are asked to model physical phenomena from phase 1 in the form of drawings, mathematical models, or simple experiments to test empirical formulas. From the first to the third meeting, they complete the images related to the initial

phenomenon. This stage aims to develop science literacy, especially in describing, interpreting, and predicting phenomena. Image modeling helps students visually represent phenomena, connect observations with scientific concepts, and practice the ability to identify important elements and organize them into meaningful representations.



Physics Modeling in Mathematical
 The more you write down the phenomenon it shows that you have numeracy skills capable of using basic mathematical numbers or symbols

1. Heat type (c)
 In the process of heating or cooling a substance without any change in form, the value of the heat required or released is proportional to the change in temperature. With the same heat, the temperature change that occurs is inversely proportional to the mass of the object

$$Q \sim \Delta T$$


$$\frac{1}{m} \sim \Delta T$$

In addition to the m and ΔT factors, the heat Q also depends on the type of substance or called the heat type of substance (c), the heat needed to change the temperature of an object is formulated as:

$Q = \dots\dots\dots$

Figure 6. Physics Modeling in the Form of Mathematical Equations in Phase 3

In Figure 6 phase 3, mathematical modeling is carried out by completing formulas in modules based on the image modeling that has been created, where students fill in blank formulas from the first to third meetings and can ask questions related to physics modeling. This stage is important to help students connect visual representations with physical concepts through mathematical equations, practice numeracy skills, and strengthen conceptual understanding with analytical thinking while providing space for clarification of understanding.



Physical Modeling in the Form of Experiments/Simple Experiments
 This experiment trains you to improve science literacy skills in evaluating and designing scientific investigations (Explain and use the methods scientists use to determine the objectivity of data)

Objective: Shows that heat can cause a change in the form of a substance from solid to liquid in butter and ice cubes.

Tools and materials :


1. Plastic container for hot water 2 pieces
2. Small plastic container 2 pieces
3. Butter to taste
4. Ice cubes to taste
5. Hot water
6. Stopwatch
7. Spoon
8. Candle
9. Match

Trial Procedure:

1. Prepare the necessary tools and materials
2. Light a candle using a lighter
3. Add the butter to the size of $\frac{1}{2}$ a tablespoon, then bake it on a candle
4. Record when the butter starts to melt and when it melts completely using the stopwatch

Figure 7. Physics Modeling in the Form of Simple Experiments in Phase 3

In Figure 7 phase 3, students conduct a simple experiment in a group by reading the procedures available in the module from the first to the third meeting, as well as being given the opportunity to ask questions related to physics modeling. This stage is important for practicing the skills of designing and evaluating scientific investigations, understanding scientists' methods, and empirically testing physical concepts. Through this activity, students' science literacy skills are strengthened, especially in critical thinking and investigating phenomena systematically.



PHASE 4 : FINDING A SOLUTION

After carrying out the objectives, tools/materials and procedures of the experiment, conduct an experiment to obtain data, then record the results on the observation table and discuss the data obtained!

Table 3. Observation Results

Substances Observed	Time to Start to Thaw (minutes)	Fully Thaw Time (minutes)	Changes That Occur
Butter on hot water			
Butter on wax			
Ice cubes on hot water			
Ice cubes on wax			

Figure 8. Phase 4 Looking for a Solution

In Figure 8 phase 4, students conduct group experiments according to the design in the module, then record the results on the observation table. This stage is important to practice testing solutions, encourage collaboration, discussion, and critical thinking, while improving science literacy through the skills of collecting and organizing data systematically.

Based on the table of observations, make a corresponding graph, by completing this stage you have numeracy skills in being able to analyze information displayed in various forms (graphs, tables, charts, diagrams and so on) and science literacy skills in interpreting data and scientific evidence (Converting data from one type to another)

Comparison of Melting Time between Butter and Ice Cubes

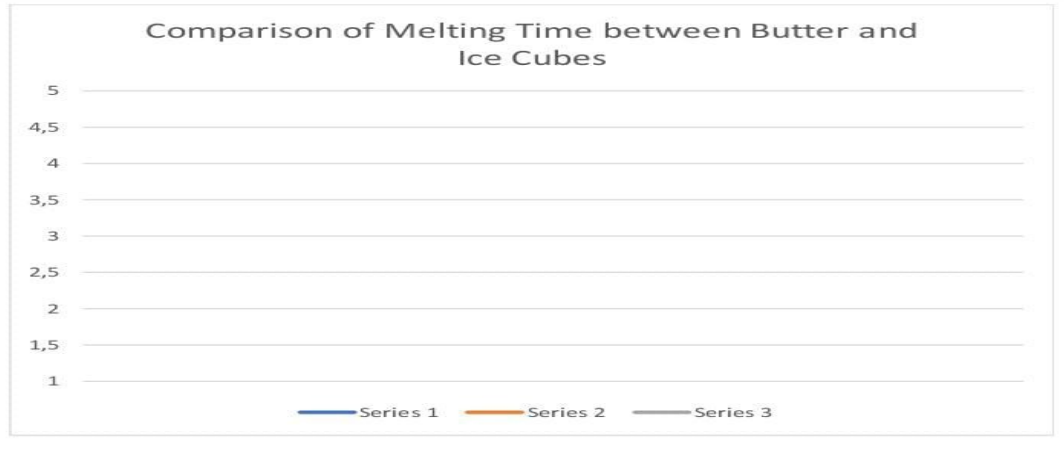



Figure 9. Creating Graphs/Diagrams/Mindmapping in Phase 4

In Figure 9 phase 4, students process the experimental data into visual representations such as graphs, diagrams, or mind mapping. This stage is important to train numeracy skills

in analyzing information, while supporting science literacy through the skills of interpreting and converting data between formats. Visualizations help students understand the patterns, variable relationships, and scientific meanings of data more easily.

DISCUSSION:




The more you write the discussion, the more you will develop science literacy skills in **interpreting scientific data and evidence** (Analyzing and predicting data) and numeracy skills in interpreting the results of analysis to predict and make decisions.

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Figure 10. Discussion in Phase 4

In Figure 10 phase 4, students have a discussion to explain the relationship between the experimental variables, interpret the data, and relate it to theory. They were also asked to explain the factors that affected the results and provide logical reasons. This stage is important to train numeracy skills in interpreting, analyzing, and predicting data, while strengthening science literacy through evaluating evidence, drawing logical conclusions, and developing analytical and reflective thinking on experimental processes and results.

CONCLUSION



Based on the data and discussion above, make a conclusion!
The more you write a Conclusion, it shows you have science literacy skills in **explaining scientific phenomena** (Applying science knowledge in a given situation)

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Figure 11. Conclusion on Phase 4

In Figure 11 phase 4, students are asked to formulate the conclusion of the experiment by summarizing the main findings and relating them to the initial phenomenon. Conclusions must be based on data that has been analyzed and relevant to scientific concepts. This stage is important to practice the skills of summarizing results logically, explaining phenomena through the application of scientific knowledge, and strengthening reflective abilities and precise and meaningful scientific communication.

Stabilization Issues


A total of 200 grams of water is at a temperature of 25°C. The water is heated to a temperature of 75°C with a water temperature of 4,200 J/kg°C. Calculate the amount of heat needed to heat the water!

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Figure 12. Stabilization Issues

In Figure 12 phase 4, students are given consolidation questions to evaluate their understanding of the concepts they have learned. Questions are presented in a variety of contexts so that students get used to applying knowledge flexibly, broaden their horizons, and strengthen their understanding of ideas. This stage also helps uncover incomplete understanding and encourages improvement in independent learning skills.

PHASE 5 : EVALUATION OF PROCESSES AND RESULTS




CORRECTION OF PROCESS/RESULTS BASED ON DISCUSSION

Pay attention to the discussion of the learning process to the answer to the consolidation question. Write down your corrections if there is a difference with the initial concept you wrote!

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FINAL CONCLUSION

Write down the final conclusions you have gained from the learning process that has been done! the more you write the final conclusion shows that you have science literacy skills in evaluating and designing scientific investigations (Evaluating and exploring a problem)

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Figure 13. Phase 5 Process and Outcome Evaluation

Phase 5 is the evaluation of processes and outcomes, where the teacher assesses the student's work, gives feedback, asks for corrections to the module, and formulates a joint conclusion. This phase is important to reflect on learning, identify errors, improve understanding, and train science literacy skills in evaluating inquiry and forming a reflective and open scientific attitude to revision.

Discussion

Students' science and numeracy literacy skills are expected to be improved through this module. The effectiveness of the temperature and heat modules can be ascertained through pre-test and post-test results. Both test results can be used to measure how much a student's ability changes before and after the use of the module (Karmila & Abidin, 2023).

The lowest pre-test score obtained was 0.00 while the highest score reached 24.00. This is because students have not yet received the modules and explanations of the material to be studied. Student pre-test data is shown in Table 6, with an average of 8.74.

As the results of the initial test show, students are unable to describe or interpret phenomena and describe changes; determine appropriate descriptions, explanations, and predictions; evaluate and investigate problems; and solve problems using scientific knowledge in a specific context because they still lack an understanding of temperature and heat.

The post-test was carried out with the aim of measuring the enhancement of students' science literacy and numeracy abilities after participating in three learning sessions using temperature and heat modules. Based on the data obtained, the students' post-test scores

were in the range of 33.00 to 98.00. These findings show that the use of modules developed by researchers contributes to improving students' science literacy and numeracy. With an average post-test score of 76.51, students showed a better understanding of temperature and heat matter, as shown in Table 4.

Result Pre-tests and Post-Tests resulted in students' science and numeracy literacy skills improving significantly after using the temperature and heat modules via P2F. Value Pre-tests which is low because students have not been exposed to the material through P2F-based modules (Veronika, 2023). They are also not used to associating the concepts of temperature and heat with science and numeracy literacy skills, such as interpreting data, reading graphs, and predicting phenomena based on quantitative data analysis. Previous modules have not been designed to build applicative scientific thinking skills, particularly in the context of science literacy and numeracy which requires the interpretation of numbers, units, graphs, and equations (Pokhrel, 2024).

After using the module, the post-test score increased by an average of 76.51. This shows that the module is effective in helping students understand the concepts of temperature and heat across the stages of systematic structured modeling. Through this module, students are trained to make observations, make predictions, make calculations, and draw conclusions based on the available data, so as to directly contribute to the improvement of their knowledge in the field of science and numeracy (Awami et al., 2022)

However, there is a variation in students' abilities. This is due to differences in initial abilities, motivation to learn, learning styles, and the support of each learning environment (Eriana et al., 2023). Students with low scores may require more time or a more individualized approach to learning, while students with high scores are likely to have better interests and analytical skills. These results show that the overall quality of physics learning can be improved through the development and implementation of appropriate modules (Mawardi, 2024).

Science and numeracy literacy is a competency that needs to be possessed by students in the current learning era, including in physics subjects. The ability to understand, discuss, and apply science in problem solving is part of science literacy which plays a role in increasing individual awareness of the surrounding environment (Dewantari & Singgih, 2020).

Explaining scientific phenomena by applying scientific knowledge to specific situations, interpreting and describing phenomena, predicting changes, and providing accurate explanations and predictions; and assessing and designing scientific investigations (evaluating and exploring a problem; explaining and using methods used in scientific investigations) are the science literacy skills tested in this study (OECD, 2023).

The tests given to students amounted to seven questions with indicators of science literacy skills, namely: 1) applying science knowledge in the situation given in question number 1, 2) interpreting the results of the analysis to predict and make decisions about question number 2, 3) identifying the appropriate descriptions, explanations, and predictions in question number 3, 4) conferring data from one type to another in question number 4, 5) Analyze and predict the data in question number 5, 6) Evaluate and explore a problem in question number 6, 7) Explain and use the methods Implemented by scientists to examine whether the data is objective in question number 7.

Shown in Table 6, students' science literacy levels are relatively low. This finding was strengthened based on the results of the researcher's discussions with teachers at SMAN 2 Banjarmasin, which showed the compatibility between the data and conditions in the field. The science literacy indicator obtained the lowest pre-test score, with an average of 0.86. These indicators use scientific methods, evaluating and investigating, explaining, and

predicting data. This shows that science literacy skills such as critical thinking, data interpretation, and contextual understanding of scientific techniques are still lacking in students. In addition, children are not yet able to respond independently and calculate correctly (Fitria & Indra, 2021). The indicator of science knowledge application had the highest pre-test score, with an average of 32.57.

This shows that students are quite used to using their science knowledge to answer questions. Students who have poor science literacy skills may be because the teaching materials used have not supported the development of these skills (Agusta, 2022). Improving students' science literacy can be achieved through applying suitable instructional models along with the utilization of relevant learning resources.

P2F model in the temperature and heat module proven successful in advancing students' knowledge of science literacy skills. In Table 6 which an increase in student achievement in each science literacy indicator. The science literacy indicator explains and uses the way scientists have the lowest post-test average score, at 63.86, and the science literacy indicator analyzes and predicts data has the highest post-test average score, at 88.86. Students are more proficient in critically assessing data as is evident from the difference in post-test scores between low indicators in explaining and using scientists' methods and in analyzing and predicting data (Lestari et al., 2022).

For today's students, science and numeracy literacy includes the ability to understand physics (Lendeon & Poluakan, 2022). The ability to apply mathematical concepts in practice is known as numeracy ability (Sari et al., 2021). In this study, students' numeracy skills were tested through several aspects, including the skill to handle solving common problems with the help of multiple numerical forms or basic concept symbols mathematical concepts, evaluating data presented presented in different formats, including graphs, tables, charts, and diagrams, followed by interpretation of the analysis results to make predictions and decision-making (Winata & Cacik, 2021).

The tests given to students amounted to seven questions with The indicators of numeracy skills are as follows: 1) Ability to use various numbers or mathematical symbols in solving daily life problems, as seen in questions 1 and 3; 2) Ability to analyze information presented in various formats (graphs, tables, charts, diagrams, etc.) in questions 4 and 5; 3) Ability to interpret analysis results to make predictions and decisions in questions 2, 6, and 7.

Table 7 displays the pre-test results, indicating that students' numeracy skills remain low. This result aligns with the findings of the researcher's interview with teachers at SMAN 2 Banjarmasin. The numeracy indicator with the lowest score was the competence in making sense of the outcomes of data analysis score of 4.10. This shows that students still have difficulties in working on numeracy problems, especially in interpreting data and relating it to the context of the given problem (Noviana, 2024). With an average score of 24.29, the numeracy skill indicator that uses various numbers or symbols achieves the highest score in Pre-test.

As part of the numeracy skills commonly used in everyday tasks, this shows that students can quite use simple math numbers and symbols. Students' numeracy failure can be caused by teaching materials that have not supported the development of their science and numeracy literacy (Agusta, 2022). Their numeracy skills can be improved by using a learning model combined with relevant educational resources.

P2F for temperature and heat modules can improve student numeracy. Table 7 shows the enhancement of students' numeracy skills achievement in each indicator. The numeracy indicator when interpreting the analysis results shows the lowest average post-

test score, which is as high as 69.14, while the numeracy indicator analyzes various forms shows the highest post-test average score of 87.67.

Average value Post-Tests The difference indicates that students have the ability to analyze numerical data visually. However, they still face difficulties in interpreting the results of the analysis, which requires a deeper understanding of the concept of numeracy (Sanjoyo et al., 2025). Question number five has a higher value than question number seven.

Post-test results on almost all science and numeracy literacy measures were improved with the use of modules. This shows that this approach helps students understand and interpret numerical data, in addition to improving their understanding of temperature and heat (Ardianti, 2024). One interesting finding is that students find it easier to analyze information in visual form, such as graphs, tables, and diagrams. However, they still struggle to understand the results of a more abstract analysis, which suggests that students need to learn more arithmetic in the context of contextual physics.

Modules designed based on P2F syntax teach students through the stages of phenomenon identification, modeling, experimentation, data analysis, and inference, resulting in increased grades Post-Tests (Sa'diah et al., 2022). Activities that require numeracy skills such as reading thermometers, calculating temperature changes, graphing temperature relationships, and inferring based on data are included in this module. The improvement of students' numeracy skills occurs naturally as a result of applying physics concepts expressed using numbers and symbols throughout the learning process in each activity.

CONCLUSIONS AND SUGGESTIONS

As indicated by the findings of the study, the use of P2F temperature and heat modules has been proven to be effective in improving students' science literacy and numeracy skills. However, there are differences in results in some skills, such as explaining the scientific process and interpreting the results of the analysis in more depth. These findings suggest that additional research is necessary to gain a deeper understanding of factors affecting student achievement, including learning styles and motivation, early abilities, and support from the learning environment. In addition, it is also necessary to evaluate whether these skill enhancements can be sustained in the long term and applied to other physics materials.

To find out how effective these modules are if applied more broadly, further research is recommended using P2F which also integrates science and numeracy literacy into other physics materials such as force, motion, electricity, or waves. In addition, it is also important to test the application of this module at different levels of education, such as in junior high school or college, to see if this module is in accordance with the thinking skills of students at that level. In the future, the development of similar modules based on interactive technology can also be an alternative to increase students' interest in learning while supporting more effective independent learning.

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