

# Development of Student Worksheets based on Problem-Solving of Temperature and Heat to Improve the Students Problem-Solving Ability

Puji Wahyu Ningsih<sup>1\*</sup>, Desy Hanisa Putri<sup>1</sup>, Andik Purwanto<sup>1</sup>

<sup>1</sup>Department of physics Education, Faculty of Teacher and Education, Bengkulu University, Bengkulu, Indonesia

Received: December 11, 2023

Revised: February 15, 2024

Accepted: February 25, 2024

Published: February 29, 2024

Corresponding Author:

Puji Wahyu Ningsih

[Pujiwahyuningsih237@gmail.com](mailto:Pujiwahyuningsih237@gmail.com)

DOI: [10.29303/jppipa.v10i2.6524](https://doi.org/10.29303/jppipa.v10i2.6524)

© 2024 The Authors. This open access article is distributed under a (CC-BY License)



**Abstract:** This study aims to describe the feasibility of Student Worksheets based on problem-solving of temperature and heat, describe increasing students' problem-solving ability, and describe students' responses to the Student Worksheets. The method used is Research and Development (R&D) with ADDIE model. Data collection techniques used in this study include interviews, questionnaires, observations, and documentation. The instruments used in this study include observation sheets, interview sheets, needs analysis questionnaire sheets, design validation questionnaire sheets, expert validation sheets, response questionnaire sheets, pretest sheets, and posttest sheets. Pretest sheets and posttest sheets are arranged based on indicators of problem-solving ability. The development process went through validity tests by three experts, and field trials by 36 students. The results showed that the developed Student Worksheets had a percentage of 92% with a very decent category. The average pre-test score and post-test score with N-gain analysis results of 0.79 showed an increase with the high category, while the students' responses showed a percentage of 93% with the very good category. Based on the results of the study, it can be concluded that student worksheets based on problem-solving on temperature and heat are very feasible to be used to improve students' problem-solving abilities in physics learning.

**Keywords:** Heat and Temperature; Problem Solving; Research and Development; Student Worksheets

## Introduction

Education is a staple in any nation. The poor quality of existing education makes the nation or country experience underdevelopment and deterioration (Nur & Kurniawati, 2022). Education in Indonesia today when viewed has ups and downs, where various kinds of educational problems and problems in Indonesia experience major challenges in realizing quality education. This problem is the biggest factor in the low quality of education in Indonesia today. This factor is certainly a special concern for the Indonesian nation, because the quality of human resources produced is very dependent on the quality of education itself (Ginting Ria R. et al., 2022).

Physics is a science that discusses natural phenomena and their symptoms, from real to abstract. Physics is one of the subjects taught in high school and most students view physics as a science that is difficult to understand. Students assume that physics is a subject that requires memorization of many formulas and is very difficult in solving problems (K. Sari, 2018). Physics as a subject in schools is expected to foster the ability to think to solve a problem in everyday life so it needs to be taught optimally in the learning process. Learning physics not only emphasizes mastery of concepts but also applies concepts in solving student problems (Maryani et al., 2022).

The main purpose of learning physics is to develop the knowledge, understanding, and analytical skills of students in the surrounding environment. Learning

### How to Cite:

Ningsih, P.W., Putri, D. H., & Purwanto, A. (2024). Development of Student Worksheets based on Problem-Solving of Temperature and Heat to Improve the Students Problem-Solving Ability. *Jurnal Penelitian Pendidikan IPA*, 10(2), 940-950. <https://doi.org/10.29303/jppipa.v10i2.6524>

physics is not only for the use of concepts but also to apply these concepts to solving physics problems. However, learning tends to emphasize mastery of concepts and exclude physics problem-solving abilities (Mariati et al., 2023). Problem-solving skills are a way to deal with the 21st century. Education in the 21st century also emphasizes problems in the real world so this learning method is very effective to apply because it involves the intelligence of individuals and groups from the environment to solve problems. Therefore, students must be prepared to live a life in the world of education, especially in improving problem-solving skills (Yuliana et al., 2019). Learning is a complex thing that can happen to a person throughout his life. Learning is a lasting change in behavior resulting from practice or other forms of experience (Doyan et al., 2021).

Based on the results of interviews with physics teachers at SMAN 4 Bengkulu City, information was obtained that there were 60% of students had not met the Minimum Completeness Criteria, where the Minimum Completeness Criteria were 80 out of a scale of 100. When observations were made in class, it showed that in physics learning, students' problem-solving abilities were still relatively low. In doing physics problems given by the teacher, students more often directly use mathematical equations without doing analysis. This is due to the lack of mastery of learners' skills in analyzing which requires reasoning and problem-solving.

Students have difficulties because the strategies used in learning are only to solve problems that require mathematical calculations. Most students, in doing the problem do not pay attention to the steps to solve it, they are only concerned with the final result. One of these problems is due to physics learning that does not touch on the problem-solving aspect. The result of learning physics that does not touch on problem-solving is that it can make students experience difficulties in problem-solving. This is appropriate in research (Al, 2022) who said that physics lessons are very interesting, but sometimes there are still many students who have not been able to solve physics problems. The problem experienced is in solving physics problems, ranging from understanding the problem to checking the answers again. Therefore, problem-solving is important for teachers to pay attention to in learning.

The lack of ability to solve students' problems needs to be found immediately. The use of learning media such as Student Worksheets is one alternative to improve students' problem-solving abilities. The presentation of Student Worksheets can be developed with various kinds of innovations. Various kinds of innovations can be applied in writing Student Worksheets, one of which is combining Student Worksheets with problem-solving models. The problem-solving model is considered appropriate enough to improve students' problem-solving abilities because this method is given a problem-

solving procedure that can guide students to solve problems according to stages. The National Education Standards Agency states that several aspects must be present in the development of Student Worksheets, namely aspects of content feasibility, language aspects, presentation aspects, and graphic aspects.

Based on the results of the interview with the physics teacher of SMAN 4 Bengkulu City, information was obtained that learning in the classroom has now used Student Worksheets, but the Student Worksheets used are still not based on lesson sequences and are directly directed to questions so that the ability to analyze problems is not optimal. According to (Edwar et al., 2021) Student Worksheets used in schools generally do not have steps that can guide students to understand the Subject. Student Worksheets will be more optimal if they are based on a learning model that teaches how to solve a problem, students can get learning experiences that teach problem-solving skills.

The problem-solving ability referred to in this study is the ability of students to use the knowledge and concepts they learn to find solutions to given problems. The problem-solving ability used in this study refers to the problem-solving ability according to Heller & Heller (2010), there are five stages in the problem-solving strategy, namely; understanding the problem; describing the problem into physical aspects; planning solutions; Execute the solution; and evaluating solutions.

Temperature and heat are one of the physical concepts that apply a lot in everyday life. Temperature and heat Subject discusses temperature and expansion, the relationship of heat with the temperature of objects and their forms, and heat transfer. Examples in everyday life include boiling water, heating ice into water, and expanding railroads.

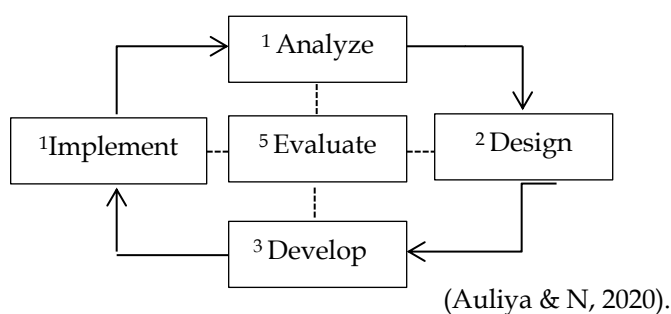
Research on the development of Student Worksheets based on problem-solving has been carried out by previous researchers, such as research conducted by (Anwar and Khabibah, 2021) to produce a developed Student Worksheets valid and effective for use. As well as the results of the questionnaire, the students' responses obtained interesting criteria. Other research conducted by (Kahar et al., 2018) which produces Student Worksheets Physics based on problem-solving developed worthy of use in measuring students' thinking skills, with very valid criteria.

From several studies that have been conducted, researchers are interested in describing the feasibility, improvement of problem-solving skills, and student responses to the development of Student Worksheets based on Problem-Solving of temperature and heat to improve problem-solving skills at SMAN 4 Bengkulu City of 11<sup>th</sup> grade. The availability of appropriate of Student Worksheets greatly supports student learning.

Based on the explanation above, research will be conducted with the title "Development of Student Worksheet based on problem-solving of temperature and heat to improve the problem-solving ability of 11<sup>th</sup> grade high school students" which is expected with teaching Subjects in the form of Student Worksheets developed to help teachers and students understand the problem-solving ability of concepts and Subjects taught in the learning process. This research is important so that educators get the right information about the application of learning models or devices that can improve the ability to solve physics problems.

**Method**

The method used in this study is the Research and Development (R&D) method. Research and Development (R&D) is a method used to design, manufacture, and validate a product (Sugiyono,2019). The model used in this study is the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The ADDIE development model has a systematic and logical sequence of stages (Prayogi et al., 2023). Research on ADDIE model development has stages that can be seen in Figure 1.



**Figure 1.** ADDIE Model

This research was conducted at SMAN 4 Bengkulu City. The research will be conducted in the odd semester of 2023/2024. The research subjects used in this study were 36 students of grade XI MIPA 1 SMAN 4 Bengkulu City.

The data collection techniques used in this study consisted of observation, interviews, questionnaires, documentation, and tests. The data collection instruments used in this study were observation sheets, interview sheets, needs questionnaire sheets, design validation questionnaire sheets, expert validation sheets, response questionnaire sheets, pretest sheets, and posttest sheets (Meutia et al., 2021). Pretest sheets and posttest sheets are arranged based on indicators of problem-solving ability. The indicators used are problem-solving indicators according to Heller & Heller (2010), namely understanding the problem; describing the problem into physical aspects; planning solutions; Execute the solution; and evaluating solutions.

Data analysis techniques carried out consist of product needs analysis, product feasibility level data analysis, data analysis to improve problem-solving abilities, and data analysis of student responses to the products being tested. Product requirements analysis using the Likert scale as in Table 1.

**Table 1.** Likert scale needs analysis

Number	Category
5	Strongly Agree
4	Agree
3	Simply Agree
2	Disagree
1	Strongly Disagree

(Uniati et al., 2019).

The result data is then analyzed using the following score interpretation Formula 1:

$$\text{Interpretasi score} = \frac{\text{Number of score obtained}}{\text{maximum number of score}} \times 100\% \quad (1)$$

(Hafifah et al., 2020).

To determine the level of product needs, the category of needs can be seen in Table 2.

**Table 2.** Categories of Needs

Number	Category
81-100%	Urgently needed
61-80%	Needed
41-60%	Simply needed
21-40%	Not required
≤20%	Strictly Not needed

(Uniati et al., 2019 with modifications).

Analysis of feasibility rate data using the Likert scale as in Table 3.

**Table 3.** Likert scale feasibility analysis

Number	Category
5	Excellent
4	Good
3	Good enough
2	Bad
1	Very Not Good

(Raihan Fauziah et al., 2022).

The result data is then analyzed using Equations 2:

$$P = \frac{\sum X}{\sum Xi} \times 100\% \quad (2)$$

Information:

- P : Eligibility percentage
- ∑ X : Number of scores obtained
- ∑ Xi : Total overall score

(Husniyah & Ramli, 2023).

To determine the feasibility level of the product developed, the feasibility category is used. Eligibility categories can be seen in Table 4.

**Table 4.** Eligibility Categories

Number	Category
81-100%	Very Worth It
61-80%	Worth It
41-60%	Pretty Decent
21-40%	Not Worth It
≤20%	Very Unworthy

(Raihan Fauziah et al., 2022).

Analysis of improved problem-solving skills using each student's pretest and posttest results. Assessment of improved pretest and posttest problem-solving skills using N-gain analysis. N-gain is used to analyze the improvement of student learning outcomes based on the acquisition of each student's pretest and posttest scores. Here is the N-gain equation used:

$$N\text{-gain} = \frac{\bar{x}_{\text{posttest}} - \bar{x}_{\text{pretest}}}{\bar{x}_{\text{max}} - \bar{x}_{\text{pretest}}} \quad (3)$$

(Wasli et al., 2022).

After calculating N-gain, then N-gain is categorized in Table 5.

**Table 5.** N-gain Category

Number	Category
$g > 0,7$	High
$0,3 < g \leq 0,7$	keep
$g \leq 0,3$	Low
$g = 0$	No Improvement
$g < 0$	There is a decrease

(Siagian, 2021).

Analysis of student responses using data from the results of student response questionnaires using a Likert scale of five and then analyzed using the following score interpretation formula:

$$Interpretasi\ score = \frac{Number\ of\ score\ obtained}{maximum\ number\ of\ score} \times 100\% \quad (4)$$

(Hafifah et al., 2020).

To find out the response of students to the product, the response category can be seen in Table 6.

**Table 6.** Response category

Number	Category
81-100%	Excellent
61-80%	Good
41-60%	Good enough
21-40%	Bad
≤20%	Very Not Good

(Raihan Fauziah et al., 2022).

## Result and Discussion

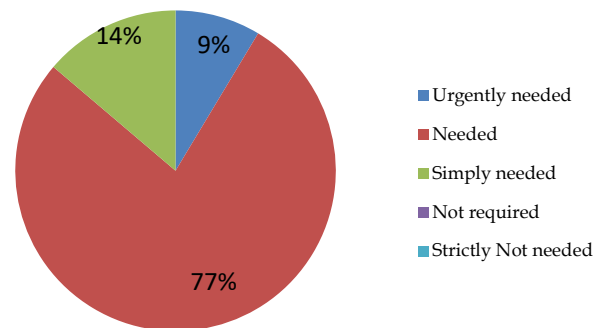
The development procedure in this research is carried out using the ADDIE development model which consists of the stages of Analysis, Design, Development, Implementation, and Evaluation (Prayogi et al., 2023).

The stages of the ADDIE model in this study are explained as follows:

### Analysis

At this stage, a problem analysis and needs analysis are carried out. At the stage of problem analysis carried out with interview and observation techniques, information was obtained that the lack of student's ability to analyze requires reasoning and problem-solving (problem-solving), learning rarely does practicum or activities that involve student activity and there are still many students who do not like physics lessons because the teaching media used is less interesting, less varied and less stimulating to students' problem-solving abilities (Meutia et al., 2021). Many students find it difficult to understand physics because the methods used are still conventional such as the lecture method, this causes students to become less excited and bored. In addition, students also often only get one-way information, without reinforcement (C. Anwar et al., 2019).

At the needs analysis stage questionnaire sheets given to 58 students. The results of the needs analysis in students can be seen in the diagram below:



**Figure 2.** The need of student worksheet based on problem-solving

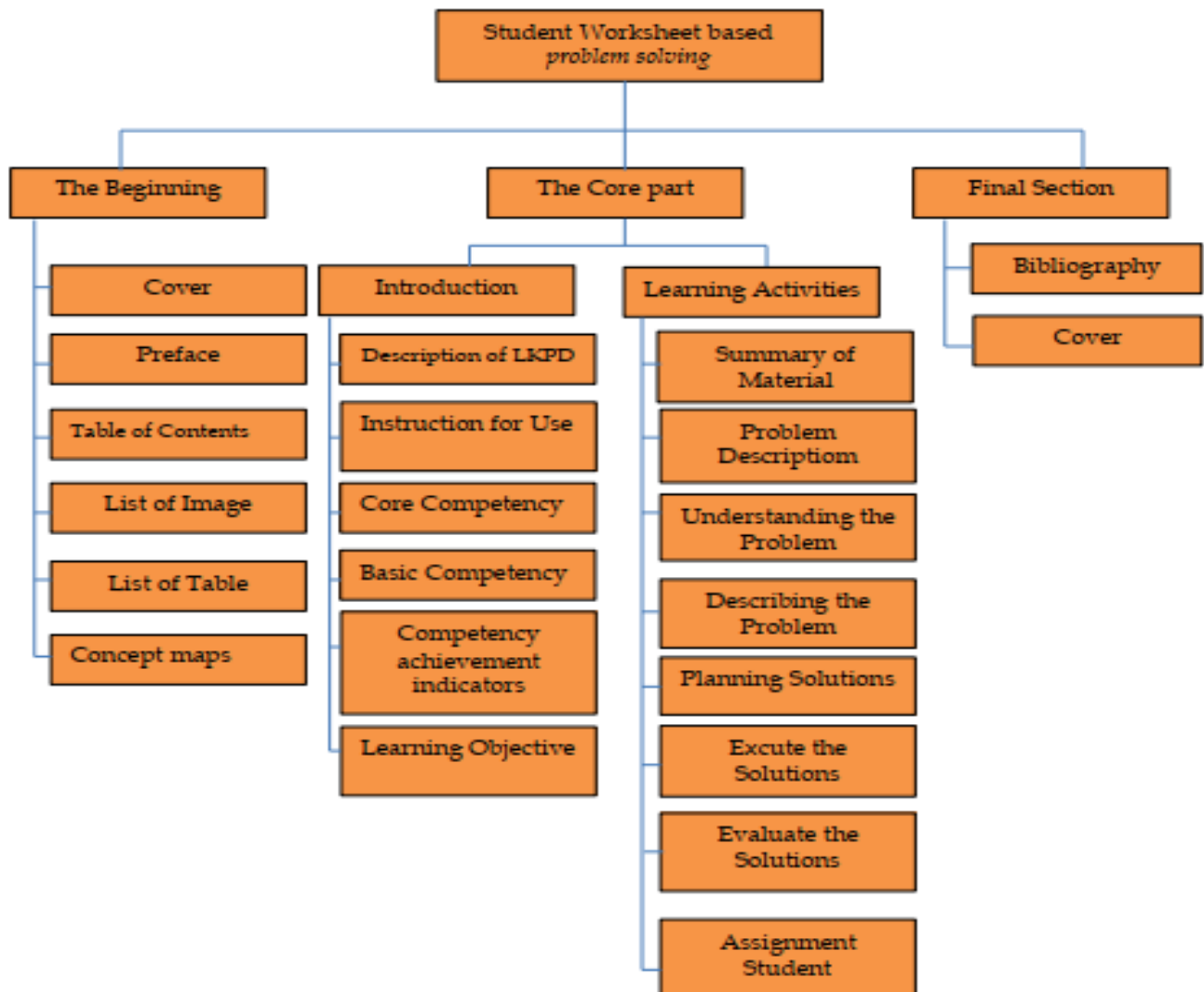
Based on Figure 2, it can be seen that 14% of students stated that problem-solving based of Student Worksheets is simply needed, 77% of students stated that problem-solving-based student worksheet is needed, and 9% of students stated that problem-solving-based of Student Worksheets is urgently needed. The need for the development of problem-solving-based teaching media to improve the results of problem-solving ability in students. According to (Siregar et al., 2023) Problem-solving is a person's ability to find solutions to the problems he faces through the acquisition and organization of information based on his understanding and knowledge Problem solving is closely related to life because in real life students will find problems that require the ability to find solutions as a way out. Problem-solving learning model is student-centered so that it makes students active, and this model is seen as effective in helping solve various problems in everyday

life (Fauziah et al., 2020). Therefore, learning experiences that connect learning material with everyday life can be helpful students deepen their understanding. From the explanation above, to solve problems, Student Worksheets is developed based on problem-solving needed by students.

*Design*

At this stage, it aims to design Barcodes of Student Worksheets by first conducting Subject review and

content review at Barcodes of Student Worksheets. The design made is the structure of Student Worksheets. The Student Worksheets design is guided by previous development research conducted by (Margaretha et al., 2022) entitled "Development of Student Worksheets on Hydrostatic Pressure Subject Using Live worksheet Media" adding the stages of problem solving in it, can be seen in Figure 3.



**Figure 3.** Product Plan of Student worksheets

The software used in the manufacture of the product is the Canva Application. In the field of education, especially in learning, the Canva application can be used as a medium that presents learning Subjects, images, videos, and animations that can be designed as attractive as possible so that it can help students understand learning Subject, so this can make students pay more attention to the lesson because the display presented in the media is interesting and interactive (Hafizah & Samosir, 2023).

*Development*

At this stage, a development process is carried out including, the stage of making problem-solving-based LKPD which will be presented as an object in research, making products by the design that has been made at the design stage and will be developed so that it becomes a learning medium that is suitable for use in the learning process. The results of Student Worksheet development can be accessed in Figure 4.



Figure 4. Barcodes of Student Worksheets

After product development, a validation process will be carried out. Validation is given to 3 validators using an expert validation questionnaire sheet. The validation questionnaire sheet is based on 5 aspects, namely, content feasibility, language, presentation feasibility, graphic feasibility, and Student Worksheets suitability for problem-solving abilities. The result of 3 validators is visible in the Table 7.

Table 7. Product eligibility results

Indicator	Percentage	Category
Fill Eligibility	93%	Very Worth It
Language	91%	Very Worth It
Presentation	92%	Very Worth It
Graphics	90%	Very Worth It
Suitability of Student worksheet based on Problem-solving	93%	Very Worth It
Average	92%	Very Worth It

Based on Table 7 assessments from three validators stated that Student Worksheets products are problem-solving-based, this is categorized as "very feasible". This shows that Student Worksheets which is made from the aspects of content feasibility, language, presentation feasibility, graphic feasibility, and suitability for problem-solving skills is very feasible to be tested for students, especially the use of Student Worksheets as a teaching medium that can stimulate students' problem-solving abilities. As for some improvement recommendations for problem-solving-based Student Worksheets, they are presented in Table 8.

Table 8. Student Worksheets improvement recommendations

Aspects	suggestions from validators
Fill Eligibility	We recommend that the Subject presented is adjusted to basic competencies and the description of the problem is adjusted to everyday
Language	Some sentence structures are not yet based on improved spelling, there are still foreign languages that have not been italicized
Presentation	We recommend that the type and font size on the Student Worksheets be adjusted again
Graphics	The layout is adjusted again for both numbering, tables, and figures
Suitability of Student Worksheet to Problem-Solving	At the stage of running the solution is considered again for the experiment, it should be adjusted to the indicators and learning objectives

Based on Table 8, input and suggestions from validators were obtained, in the feasibility aspect, the content of each Subject in the Student Worksheets has been adjusted to the basic competencies and the description of problems in the Student Worksheets has been made based on daily life. In the linguistic aspect, sentence structure has been adjusted to the improved spelling and all foreign languages contained in the Student Worksheets have been italicized. In the aspect of the feasibility of presentation, the type and size of the font have been adjusted and have been improved well. In the graphic aspect, the layout has been adjusted in terms of numbering, tables, and images so that it looks attractive. For aspects of Student Worksheets suitability to problem-solving at the stage of running solutions for experimental experiments, it has been adjusted to the indicators and learning objectives.

*Implementation*

At this stage, a product trial will be carried out that has been revised from the validation results. Product

trials aim to collect data that can be used as a basis to determine student responses to Student Worksheets that have been developed and to see improvements in students' problem-solving abilities using pretest and posttest. Product trials were conducted at SMAN 4 Bengkulu City in class XI MIPA 1 which amounted to 36 students.

This stage, begins with the implementation process in the form of giving pretest questions to determine students' initial problem-solving abilities on temperature and heat Subject. After that, product trials in the form of student worksheet based on problem-solving were carried out on students, by forming students into several groups. During implementation, all stages in Student Worksheets are carried out from learning to understand the problem, then describing the problem into aspects of physics, then planning solutions, running solutions by doing practicum according to the Subject subchapter, and evaluation and expansion with group presentations in front of the class. That way students learn to reason and analyze with group

members, students become active in seeking information, students become active in asking questions, and students become active in expressing opinions during the learning process. Students are invited to think actively because the problems raised based on everyday life such as on temperature and expansion Subject are taken problems from balloons that pop due to the scorching heat of the sun.

After completing the implementation of all learning activities, students are given posttest questions that aim

to determine students' problem-solving abilities after being treated. there are several things that cause students difficult to solve physics problems physics problems, including students not understand the form of the question, lack of ability to identify the problem, and lack of concept understanding (Mahrita et al., 2023). The pretest and post-test results of students on each indicator can be seen in Figure 5.

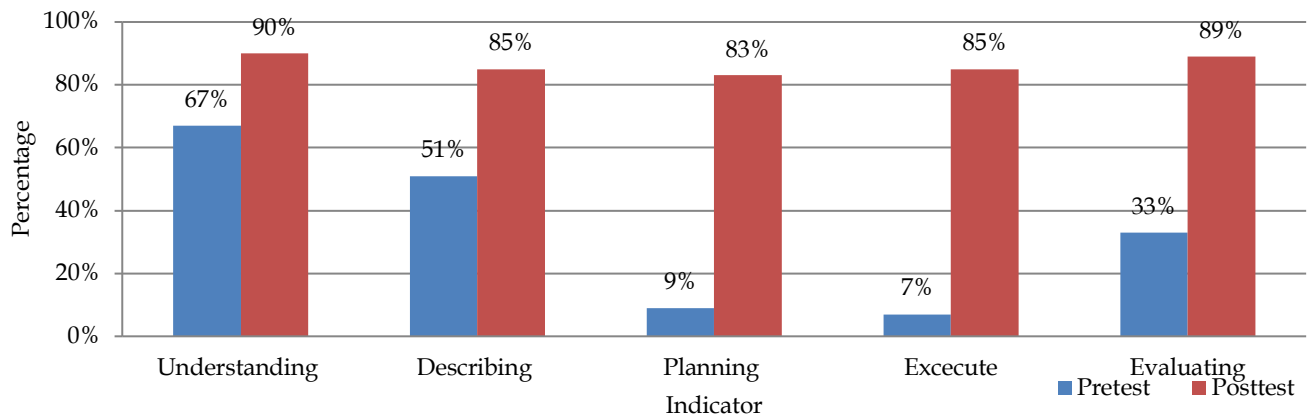


Figure 5. Pretest and Posttest chart

Based on Figure 5 it is obtained that at the stage of understanding the problem, where students are asked to rewrite the main problem in the form of known and asked in the pretest data 67% can do and in the post-test data 90% of students can do. At the stage of describing the problem in physical aspects, namely the main problem will be described into symbols of physical quantities using International units, pretest data shows 51% of students can do and in post-test data 85% of students do. In solving problems, students not only rely on rote memorization, but also analyze information and think critically to examine problems in everyday life(I. P. M. Sari et al., 2023). At the stage of planning a solution, which is to make steps to solve the problem using physical equations, the pretest data shows 9% of students who do it and in the posttest data 83% of students who can do it. At the stage of running stage solution, that is, students will do calculations using the equation in the previous stage, Pretest data shows 7% of students who do, and in posttest data 85% of students who can do. It can be seen at the stage of planning a solution when the pretest percentage is still low because many students have not been able to provide equations and run the lowest percentage solutions because they do not have the equation to continue doing calculations. At the stage of evaluating the solution, students are asked to double-check the answers by filling in the statement table provided, The pretest data shows 33% of students who do, and in posttest data 89% of students who can do. During the pretest, students are still confused about

doing questions because at school they are only taught to do questions mathematically without doing analysis. There is an improvement after treatment. The low success rate of This indicator is caused by several factors, namely students are rarely trained in problem solving skills in learning and long text-shaped problems make students less careful so that the problem planning made is less than optimal (Herawati & Wilujeng, 2023).

These results show that the learning model affects students' problem solving ability. In this case, the PS model emphasizes students to be active thinkers. Some steps of the PS model give a special impression to students. Hands-on research or practice activities help students to understand the material well due to direct experience with the environment around them. During the implementation of learning, students feel happy and actively asked questions. According to (Ichsan et al., 2019) environment-based learning is a 21st century learning guide and makes learning different. This is by the results of research conducted by (Lestari et al., 2022) which suggests that learning using problem-solving-based teaching media can improve students' problem-solving abilities in learning. Other studies (Ridwan et al., 2021) state that problem-solving-based learning is effective for improving problem-solving skills in students.

Based on the pretest and posttest results, N-gain calculations are carried out to determine the category of improvement in problem-solving ability obtained by

students. The results of the average values obtained can be seen in Table 9.

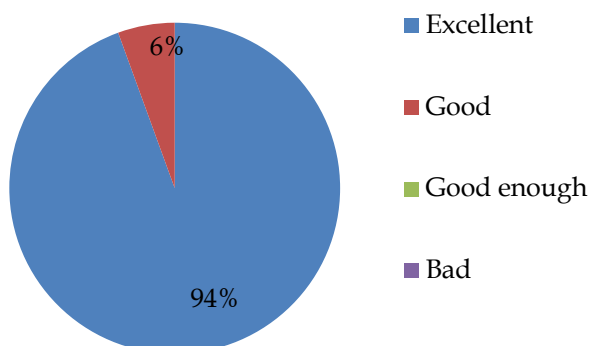
**Table 9.** N-gain Analysis Results

Data	Pretest	Posttest	N-gain	Category
Min value	17	56		
Max value	61	100		
Average	33.03	85.97	0.79	High

Based on Table 9, it was obtained that the pretest and posttest results of 36 students obtained an N-gain of 0.79 which shows that there is an increase in the high category. The Problem-Solving model is a way of providing understanding by stimulating students to pay attention, study, and think about a problem for further analysis of the problem as an effort to solve the problem (Mariati et al., 2023). In other studies (Panjaitan et al., 2023) The problem-solving model has the potential to train students' ability to face various problems to be solved alone or together. In problem-solving, learners learn independently to identify the cause of the problem and alternatives to solve the problem.

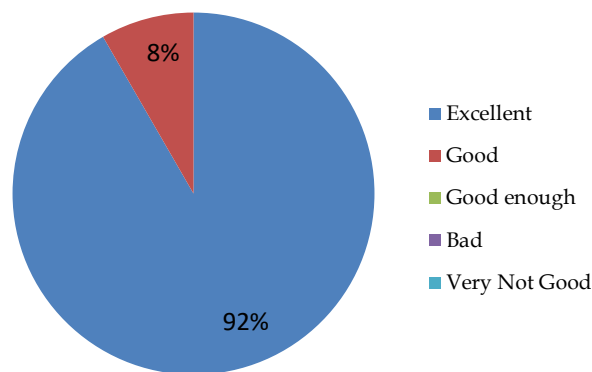
Problem solving is one alternative that can develop students' thinking skills (reasoning, communication, and connection) in solving problems. This can be seen from the N-gain result of 0.79 with the high category. This is in line with research (Yuberti et al., 2019) The problem-solving model has the potential to train students' ability to face various problems to be solved alone or together. In problem-solving, learners learn independently to identify the cause of the problem and alternatives to solve the problem. Problem solving is one alternative that can develop students' thinking skills (reasoning, communication, and connection) in solving problems. This can be seen from the N-gain result of 0.79 with the high category. This is in line with research (Sudarsono et al., 2022).

Then a response analysis was carried out to find out how students responded to the product developed using the response questionnaire given to 36 students, the assessment of the response questionnaire was divided into three aspects, namely in terms of appearance, presentation of Subject, and benefits of Student Worksheets.



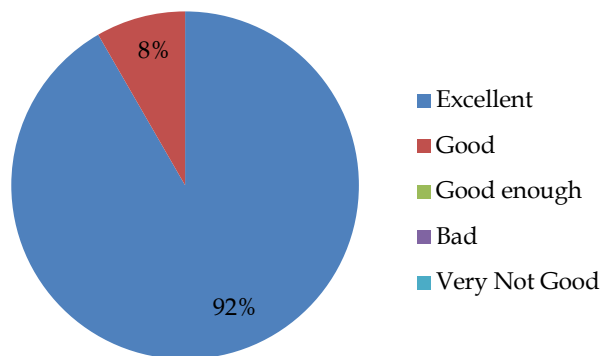
**Figure 6.** Student Worksheet display response

Based on Figure 6 it was obtained that 94% of students stated the Student Worksheets display was very good, and 6% of students stated the Student Worksheets display was good. On the aspect of Student Worksheets display. In terms of the appearance of Student Worksheets in the form of an attractive cover, and ease of reading text and writing, the images contained in Student Worksheets are clear and not blurry, and the combination of colors used is interesting.



**Figure 7.** Response of Subject presentation

Based on Figure 7, it was obtained that 92% of students stated that the presentation of the Subject was very good, and 8% of students stated that the presentation of the Subject was good. In terms of presenting Subject in the form of concepts and descriptions of problems based on daily life, the presentation of Subject encourages students to discuss with groups, and ease of students in understanding sentences, symbols, or symbols contained in Student Worksheets. Problem solving skills are able to guide students to develop thinking processes, improve concentration, and sharpen analytical skills (Khairani & Prodjosantoso, 2024).



**Figure 8.** Student worksheet Benefit Response

Based on Figure 8 it was obtained that 92% of students stated the benefits of Student Worksheets were very good, and 8% of students stated the benefits of Student Worksheets were good. In terms of the benefits



of Student Worksheets in the form of Student Worksheets, students become interested in learning, train students in identifying problems, and train students in analyzing problems. Using student worksheets in learning activities can encourage students to process the material they have studied, individually and with their friends in the form of group discussions (Ahmadiyah et al., 2023). Based on the results of the responses obtained, the categories of student responses will be seen in Table 10.

**Table 10.** Results of Student Respons

Indicator	Percentage	Category
Display of Student Worksheets	94%	Excellent
Presentation of Subject	92%	Excellent
Benefit of Student Worksheets	92%	Excellent
Average	93%	Excellent

Based on Table 10, it is obtained that the average percentage of assessment of all aspects is 93% with a very good category. This shows that Student Worksheets made from the aspects of Student Worksheets Display, Subject Presentation, and Student Worksheets Benefits is very good to use.

#### Evaluation

At this stage, evaluation is carried out at each stage of development (formative evaluation) and the end of the development process (summative evaluation). In the Analyze stage, problem analysis and needs analysis are carried out which are then evaluated so that it is found that problem solving-based Student Worksheets is needed by students to improve problem-solving skills. At the Design stage, namely making the initial design of the product then evaluated by getting suggestions and input from the supervisor who will make the product better to be able to enter the development stage. At the Development stage, namely creating and developing products, expert validation and evaluation are carried out by getting suggestions and input from validators, and then improvements are made so that the product is worthy of trial. At the Implementation stage, namely implementing and testing the product and then evaluating the results obtained, by obtaining an N-gain of 0.79 in the high category, 93% of students responded very well to the product developed. Student Worksheets based on problem-solving of temperature and heat Subject obtained good results in helping students learn temperature and heat Subject and was able to improve problem solving skills as seen from a high N-gain score of 0.79, so that the product developed in the form of Student Worksheets based on problem-solving temperature and heat Subject is very feasible and good to be applied in physics learning to improve students' problem-solving abilities.

## Conclusion

Based on the results of the research that has been done, it can be concluded that the worksheets of students based on problem-solving on the temperature and heat developed obtained very feasible criteria based on feasibility tests that have been carried out with a percentage of 92%. Then Problem-solving student worksheets can improve students' problem-solving abilities as shown by an average N-gain score of 0.79 with a high category. And students responded very well to the development of Problem-solving-based student worksheets with a percentage of 93% indicating that the products developed were classified as very good. So that the results of this study show that student worksheets based on problem-solving on temperature and heat are very feasible to be used to improve students' problem-solving abilities in physics learning.

#### Acknowledgments

The author would like to thank the Physics Education Study Program, FKIP Universitas Bengkulu for granting permission to participate in the Merdeka Belajar Kampus Merdeka (MBKM) activity. The author also expressed his gratitude to SMAN 4 Bengkulu City for helping to carry out this research.

#### Author Contributions

This article was written by 3 authors, namely Puji Wahyu Ningsih, Desy Hanisa Putri, and Andik Purwanto. All authors jointly complete the stages in the article.

#### Funding

The research received no external funding.

#### Conflicts of Interest

The author states there is no conflict of interest.

## References

- Ahmadiyah, N., Amin, B. D., & Sari, S. S. (2023). Development of Problem Based Learning Oriented Student Worksheets in Improving Students' Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, 9(2), 959–964. <https://doi.org/10.29303/jppipa.v9i2.2828>
- Al, A. I. A. P. (2022). Analisis Kemampuan Pemecahan Masalah Siswa pada Materi Momentum dan Impuls di SMK. *Edukatif: Jurnal Ilmu Pendidikan*, 4(3), 3554–3559. <https://doi.org/https://doi.org/10.31004/edukatif.v4i3.2686>
- Anwar, C., Siregar, A., Yuberti, Y., Zelia, N., Widyanti, Diani, R., & Wekke, I. S. (2019). Effect Size Test of Learning Model ARIAS and PBL: Concept Mastery of Temperature and Heat on Senior High School Students. *EURASIA Journal of Mathematics, Science and Technology Education*, 15(3), 1–9. <https://doi.org/https://doi.org/10.29333/ejmste>

- /103032
- Anwar, M. S., & Khabibah, N. (2021). Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis Problem Solving. *Fraktal: Jurnal Matematika Dan Pendidikan Matematika*, 2(1), 1-13. <https://doi.org/https://doi.org/10.35508/fractal.v2i1.3590>
- Auliya, L., & N, L. (2020). the Development of Miss Ppl (Advanced Microsoft Power Point) Learning Media At Elementary School. *JURNAL PAJAR (Pendidikan Dan Pengajaran)*, 4(4), 703. <https://doi.org/10.33578/pjr.v4i4.8027>
- Doyan, A., Rahman, M. M., & Sutrio, S. (2021). Development of Student Worksheets Based on a Multi-Representation Approach to Improve Students' Mastery of Sound Wave Concepts. *Jurnal Penelitian Pendidikan IPA*, 7(SpecialIssue), 175-179. <https://doi.org/10.29303/jppipa.v7ispecialissue.1201>
- Edwar, S. N., Roza, Y., & Kartini, K. (2021). Development of Students Work Sheets (LKPD) with A Problem-Based Learning Model (PBM) in The Context of Riau Traditional Games in Circle Materials. *Journal of Educational Sciences*, 5(2), 374. <https://doi.org/10.31258/jes.5.2.p.374-382>
- Fauziah, M., Marmoah, S., Murwaningsih, T., & Saddhono, K. (2020). The effect of thinking actively in a social context and creative problem-solving learning models on divergent-thinking skills viewed from adversity quotient. *European Journal of Educational Research*, 9(2), 537-568. <https://doi.org/10.12973/eu-jer.9.2.537>
- Ginting Ria R., Ginting Egi V., Hasibuan R. J., & Perangin-angin L. M. (2022). Analisis Faktor Tidak Meratanya Pendidikan Di Sdn0704 Sungai Korang. *Jurnal Pendidikan Indonesia*, 3(4), 407-416. <https://doi.org/https://doi.org/10.59141/japendi.v3i04.778>
- Hafifah, A., Kasrina, K., & Rahman, A. S. (2020). Desain dan Validitas Lembar Kerja Peserta Didik berdasarkan Keragaman Ikan Di Sungai Pura Bengkulu Utara. *Diklabio: Jurnal Pendidikan Dan Pembelajaran Biologi*, 4(November), 121-128. <https://doi.org/https://doi.org/10.33369/diklabio.4.2.121-128>
- Hafizah, Z., & Samosir, K. (2023). Pengembangan Media Pembelajaran Interaktif Berbasis Aplikasi Canva untuk Meningkatkan Kemampuan Pemecahan Masalah Matematis siswa kelas VIII SMP Nurul Islam Indonesia Medan. *Nautical: Jurnal Ilmiah Multidisiplin*, 2(1), 42-51.
- Herawati, N. I., & Wilujeng, I. (2023). Improving Problem Solving Ability Through Problem Based Learning E-Modules. *Jurnal Penelitian Pendidikan IPA*, 9(9), 6787-6794. <https://doi.org/10.29303/jppipa.v9i9.4622>
- Husniyah, R., & Ramli, R. (2023). Development of Physics Interactive Multimedia Based on STEM Approach Class XI SMA. *Jurnal Penelitian Pendidikan IPA*, 9(5), 3899-3904. <https://doi.org/10.29303/jppipa.v9i5.3542>
- Ichsan, I. Z., Sigit, D. V., Miarsyah, M., Ali, A., Arif, W. P., & Prayitno, T. A. (2019). HOTS-AEP: Higher order thinking skills from elementary to master students in environmental learning. *European Journal of Educational Research*, 8(4), 935-942. <https://doi.org/10.12973/eu-jer.8.4.935>
- Kahar, M. S., Wekke, I. S., & Layn, M. R. (2018). Development of Problem Solving-Oriented Worksheet of Physics Learning in Senior High School. *Jurnal Ilmiah Pendidikan Fisika Al-BiRuNi*, 07(2), 79-90. <https://doi.org/10.24042/jipfalbiruni.v7i2.2802>
- Khairani, R. N., & Prodjosantoso, A. K. (2024). The Effect of Creative Problem Solving Models with Ethnoscience on Students ' Problem Solving Ability and Scientific Attitudes. *Jurnal Penelitian Pendidikan IPA*, 10(1), 360-370. <https://doi.org/10.29303/jppipa.v10i1.5734>
- Lestari, T., Asih, B., Prayitno, B. A., Retno, S., & Ariani, D. (2022). Improving the Problem-Solving Skill of Students using. *Jurnal Penelitian Pendidikan IPA*, 8(3), 1448-1452. <https://doi.org/10.29303/jppipa.v8i3.1696>
- Mahrita, E., Arifuddin, M., & Dewantara, D. (2023). Materi Ajar Usaha dan Energi dengan Pengajaran Langsung Untuk Meningkatkan Keterampilan Pemecahan Masalah Peserta Didik Di keterampilan pemecahan masalah berperan penting dalam menghadapi tantangan dan peluang dalam kehidupan nyata merencanakan pemecahan. *JPF (Jurnal Pendidikan Fisika) FKIP UM Metro*, 11(1), 1-16. <https://doi.org/http://dx.doi.org/10.24127/jpf.v11i1.7218>
- Margaretha, Y., Almaida, P., Nurholipah, S., Oktaviani, I., & Saefullah, A. (2022). Pengembangan LKPD Interaktif pada Materi Tekanan Hidrostatik menggunakan Media Liveworksheet. *Jurnal Luminous: Riset Ilmiah Pendidikan Fisika*, 1(1), 17-25. <https://doi.org/https://doi.org/10.31851/luminous.v3i1.6713>
- Mariati, Ilyas, & Ulfa, L. (2023). Menyelesaikan Soal Fisika dengan Menggunakan Model Problem Solving di SMA N 1 Indrajaya. *Jurnal Sosial Humaniora Sigli (JSH)*, 6(1), 10-25. <https://doi.org/https://doi.org/10.47647/jsh.v6i1.1636>
- Maryani, M., Nisak, M. S., & Supriadi, B. (2022). Implementation of Google Sites Web-Based Learning Media to Improve Problem Solving Skills for High School Students the Subject of Sound

- Waves. *Jurnal Penelitian Pendidikan IPA*, 8(4), 2430–2438. <https://doi.org/10.29303/jppipa.v8i4.2037>
- Meutia, F., Nurdin, N., & Winarni, S. (2021). Development of e-Student Worksheets Based on Multiple Representations of Factors Affecting Reaction Rates. *Jurnal Penelitian Pendidikan IPA*, 7(2), 129. <https://doi.org/10.29303/jppipa.v7i2.533>
- Nur, F., & Kurniawati, A. (2022). Meninjau Permasalahan Rendahnya Kualitas Pendidikan di Indonesia dan Solusi. In *AoEJ: Academy of Education Journal* (Vol. 13, Issue 1). <https://doi.org/OI:https://doi.org/10.47200/aoej.v13i1.765>
- Panjaitan, S. N., Mansyur, A., & Syahputra, H. (2023). Pengembangan LKPD Elektronik ( E-LKPD ) Berbasis Problem- Solving untuk Meningkatkan Kemampuan Pemecahan Masalah Matematis dan Kemandirian Belajar Peserta Didik SMP IT Indah Medan. *Jurnal Cendikia: Jurnal Pendidikan Matematika*, 07(June), 1890–1901. <https://doi.org/https://doi.org/10.31004/cendekia.v7i2.2341>
- Prayogi, E. F., Wahyuni, S., & Ridlo, Z. R. (2023). The Development of Electronic Student Worksheet to Improving Higher Order Thinking Skills in Temperature and Heat Material. *Jurnal Penelitian Pendidikan IPA*, 9(8), 6667–6674. <https://doi.org/10.29303/jppipa.v9i8.3902>
- Raihan Fauziah, N., Kemala Dewi, N., & Syahrul Jiwandono, I. (2022). Pengembangan Media Poster Muatan PPKN Materi Pancasila Kelas IV. *Journal of Classroom Action Research*, 4(4), 7–14. <https://doi.org/10.29303/jcar.v4i3.2085>
- Ridwan, M. R., Retnawati, H., Hadi, S., & Jailani. (2021). The Effectiveness of Innovative Learning on Mathematical Problem- Solving Ability : A Meta-Analysis. *International Journal of Research in Education and Science (IJRES)*, 7(3), 910–932. <https://doi.org/https://doi.org/10.46328/ijres.2287>
- Sari, I. P. M., Jatmiko, B., & Suprpto, N. (2023). Students' Physics Problem-Solving Skills in Daily Life Context: Between Confession and Fact. *Jurnal Penelitian Pendidikan IPA*, 9(1), 231–241. <https://doi.org/10.29303/jppipa.v9i1.2561>
- Sari, K. (2018). Analisis Kesulitan Siswa dalam Menyelesaikan Soal-soal pada Pokok Bahasan Suhu dan Kalor di SMA Negeri 8 Banda Aceh. *Serambi Akademica*, VI(2), 77–84. <https://doi.org/https://doi.org/10.32672/jsa.v7i2>
- Siagian, M. V. (2021). Pengembangan Perangkat Pembelajaran PBM Untuk Meningkatkan Kemampuan Pemecahan Masalah Matematis. *TIN: Terapan Informatika Nusantara*, 1(11), 551–556. <http://ejournal.seminar-id.com/index.php/tin/article/view/738>
- Siregar, R., Dewi, W. S., Putra, A., & Hidayati. (2023). Effect of Problem-Based Learning Model on Students' Physics Problem Solving Ability: A Meta-Analysis. *Jurnal Penelitian Pendidikan IPA*, 9(4), 2103–2109. <https://doi.org/10.29303/jppipa.v9i4.3291>
- Sudarsono, Kartono, Mulyono, & Scolastika, M. (2022). The Effect of STEM Model Based on Bima ' s Local Cultural on Problem Solving Ability. *International Journal of Instruction*, 15(2), 83–96. <https://doi.org/https://doi.org/10.29333/iji.2022.1525a>
- Sugiyono. (2019). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Bandung: Alfabeta
- Uniati, O., Jumiarni, D., & Yani, A. P. (2019). Pengembangan Lembar Kerja Peserta Didik Berdasarkan Keragaman Jenis Tanaman Di Green Chemistry Dan Kebun Biologi Universitas Bengkulu. *Diklabio: Jurnal Pendidikan Dan Pembelajaran Biologi*, 3(1), 17–24. <https://doi.org/10.33369/diklabio.3.1.17-24>
- Wasli, M., Hikmawati, Busyairi, A., & Rokhmat, J. (2022). Pengembangan Perangkat Pembelajaran Berbasis Discovery Learning Untuk Meningkatkan Kemampuan Berpikir Kreatif dan Hasil Belajar Peserta Didik. *Jurnal Ilmiah Profesi Pendidikan*, 7(4b), 2569–2579. <https://doi.org/https://doi.org/10.29303/jpp.v7i4b.1036>
- Yuberti, Latifah, S., Anugrah, A., Saregar, A., Misbah, & Jermittiparsert, K. (2019). Approaching Problem-Solving Skills of Momentum and Impulse Phenomena Using Context and Problem-Based Learning. *European Journal of Educational Research*, 8(4), 1217–1227. <https://doi.org/10.12973/eurjer.8.4.1217>
- Yuliana, A. S., Parno, P., & Taufiq, A. (2019). Analisis Kemampuan Pemecahan Masalah Siswa Berdasarkan Rubrik yang Dikembangkan Docktor pada Materi Suhu dan Kalor. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, 4(4), 524. <https://doi.org/10.17977/jptpp.v4i4.12346>