



# Development of Problem Based Learning Oriented Student Worksheets in Improving Students' Critical Thinking Skills

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Received: December 29, 2022

Revised: February 20, 2023

Accepted: February 25, 2023

Published: February 28, 2023

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DOI: [10.29303/jppipa.v9i2.2828](https://doi.org/10.29303/jppipa.v9i2.2828)

**Abstract:** This research is a research on the development of Problem Based Learning oriented student worksheets to improve the critical thinking skills of class X MIPA students of SMAN 22 Makassar. This study aims to describe the feasibility of PBL-oriented students' worksheet teaching materials, practitioners' assessment of PBL-oriented, the effectiveness of PBL-oriented Student Worksheets in learning physics. The subjects of this research trial were 38 class X MIPA students at SMAN 22 Makassar and 10 students were tested on the Physics Teacher Consultation Community. The type of research used is the research and development method. Research on the development of student worksheets is oriented towards using the 4D model which consists of define, design, develop, and disseminate. The instruments used in this study were teaching material validation sheets, practitioner response questionnaires and students' critical thinking skills test instruments. The eligibility criteria for learning media are seen from the aspect of its validity. The practicality criterion is seen from the practitioner's assessment of the teaching materials, and the effectiveness criterion is seen from the increase in students' critical thinking skills test results. Based on the results of the analysis, the following conclusions were obtained: (1) the teaching materials in the form of PBL-oriented student worksheets which were developed, based on expert judgment using Aiken V index analysis, were declared valid and suitable for use with minor revisions; (2) teaching materials in the form of PBL-oriented student worksheets in terms of the response of physics teacher practitioners are in the very good category; (3) the effectiveness of teaching materials in the form of PBL-oriented student worksheets seen from the ability of students' understanding of concepts analyzed by N-gain obtained an average value of 0.51 in the medium category which means that there is an increase in students' critical thinking skills so that it can be said that the teaching materials in the form of PBL-oriented student worksheets which were developed were effective in increasing students' conceptual understanding abilities.

**Keywords:** Critical thinking skills; Effectiveness; Student worksheets

## Introduction

Physics is a science or natural science whose learning discusses natural phenomena and symptoms systematically. Physics is a part of science that has a contribution to human life and knowledge. This knowledge is not only in the form of facts, concepts and principles, but the discovery of a process. Students in the discovery process are expected to be able to think

creatively, be scientific, and be able to develop skills using the scientific method.

The teaching and learning process that takes place in schools is carried out based on the applicable curriculum. Currently the curriculum used is the 2013 curriculum, which previously replaced the Education Unit Level Curriculum (KTSP). The 2013 curriculum directs teaching and learning in a more student-centered process to develop creativity, create fun, challenging and contextual conditions (Irmayanti, 2015). The

### How to Cite:

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>

government requires students to have skills, including creative, critical, productive, independent, collaborative, and communicative (Permendikbud, 2016).

Critical thinking has an important role. Because, with adequate critical thinking skills students will more easily master the content of each subject. By thinking critically, students will be able to construct their knowledge better.

Based on initial observations conducted at SMAN 22 Makassar on August 23, 2021, by conducting an interview with a physics teacher, it was found that students had their critical thinking skills measured, but the results obtained were still low. So that from these results have not been able to hone and improve critical thinking skills. This is evident when students are given questions related to critical thinking skills, students are still not able to answer questions according to indicators of critical thinking skills, namely providing simple explanations, building basic skills, managing strategies and tactics, providing further explanations and concluded. From these questions the students were still not able to answer the questions properly and correctly. So it still needs to be developed further critical thinking skills. Critical thinking skills are needed in the learning process, because with critical thinking skills, students will be better able to associate the physics learning material obtained with everyday life.

Another thing that was also obtained during the interview was that the teacher still used the learning process delivered conventionally (the lecture method). So that in the learning process students are less actively involved. Dominated by the teacher, this learning process causes students to be less able to find and find the knowledge, skills, and attitudes they need for themselves. They only get a lot of knowledge from what the teacher conveys. Causing students when given assignments or during tests will tend to cheat.

Based on interviews with teachers in the field of physics studies at SMAN 22 Makassar, they also stated that in the physics learning process they had not used the developed student worksheets. Still using student worksheets that contain a collection of questions. This causes students to be less motivated to be able to freely carry out learning activities, and to sharpen students' critical thinking skills less.

The problems encountered in the learning can be overcome by using a learning model that involves students actively in the learning process. One of the learning models in question is the problem-based learning model or Problem Based Learning (PBL).

Appropriate learning models can provide opportunities for students to build their own understanding. In this model students are directed to be more creative, and independent of existing problems (Alfieri et al., 2011). In addition, active learning has a

positive effect on improving students' critical thinking skills (Peter, 2012).

PBL encourages students to increase their curiosity which can then explore the knowledge they have. This is in accordance with the opinion of Alastair (2002), he stated that the process of giving problems and the process of finding answers in learning can help students to more easily understand the material being studied. The same thing was mentioned by Pepper (2009) who stated that problem-based learning can improve student achievement because it creates learning conditions that make students active, so that students can build their knowledge and can integrate lessons learned at school in everyday life.

Pepper (2009) says, problem-based learning can enhance students' learning experiences. Belt et al. (2002) also revealed that problem-based learning can increase student motivation. Learners can become more independent, reliable problem solvers, also have professional skills.

This opinion is reinforced by Echavarría (2010) that problem-based learning is a pedagogical strategy that is centered on students, in which students will examine problems in everyday life and work in teams or groups, thereby being able to train students to be responsible in their own learning and change the role of educator to facilitator.

With PBL, students in learning can be more independent in solving given problems. From the process of finding and solving problems, students can improve their critical thinking skills. The relationship between learning problem based learning and critical thinking skills is that, by using problem based learning, teachers can train students' critical thinking skills. Because, when students carry out the process of finding solutions to a given problem, students will use their thinking system, namely using prior knowledge related to critical thinking indicators, namely providing simple explanations and building basic skills. As well as during the process of collecting data from existing problems, students will use their critical thinking skills, which are related to managing strategies and tactics.

Furthermore, from problem solving that is retrieved back to related to theory, this leads to critical thinking skills, namely providing further explanation. Because the theory obtained must be understood and explained in order to form a relevant theory and argument. Finally, from the theory obtained an evaluation is carried out, this is related to critical thinking skills in concluding, starting from the discovery process so that students can carry out a problem solving.

In addition to appropriate learning models, students' critical thinking skills are also influenced by teaching materials that do not involve students actively, so that students do not maximize their critical thinking skills (Prastowo, 2012). Ministry of National Education

(2004) defines student worksheets as a sheet which contains student activities, usually in the form of instructions or processes for completing a task, the task must also be clear on the basic competencies to be achieved. Arief (2015) also explained regarding student worksheets, he revealed, student worksheets is a tool that can help and facilitate students in learning activities, so that interaction between students and teachers will improve students' thinking skills. Student worksheets is a student practice sheet that is done and carried out systematically and continuously for a certain period of time (Ramlawati et al., 2014). The use of student worksheets in learning activities can encourage students to process the teaching materials studied, both individually and together with their friends in the form of group discussions (Suhadi, 2007).

Based on what was explained above, researchers feel it is important to develop problem-oriented student worksheets or problem-based learning. With problem-based learning-oriented student worksheets, students will be fully involved in the teaching and learning process. By giving the problems that exist in student worksheet activities students will be triggered in solving problems, either through group discussions, practicum to activities answering problems related to everyday life. So that it can improve high-level thinking skills or students' critical thinking skills.

In connection with this background, it encouraged researchers to take the title "Development of Problem Based Learning Oriented Student Worksheets to Improve Students' Critical Thinking Skills".

**Method**

This type of research is Research and Development (R&D). The development model used in this study is the 4D model which consists of four stages, the stages passed in the development of PBL-oriented worksheets are shown in Figure 1.

Researchers in collecting data in this study, using data collection techniques in the form of validation, questionnaires and tests of critical thinking skills. The subjects of this study were 38 class X MIPA students at SMAN 22 Makassar and were tested in the Physics Teacher Consultation community with 10 people. It was carried out in the 2021/2022 Academic Year at SMAN 22 Makassar.

The research design used was the Pretest-Posttest Design. In this design the test was carried out twice, namely before giving treatment and after giving treatment. The test carried out before giving the treatment (O1) is called the pre-test and the test after giving the treatment (O2) is called the post-test. According to Arikunto (2013) this trial design is shown in Figure 2.

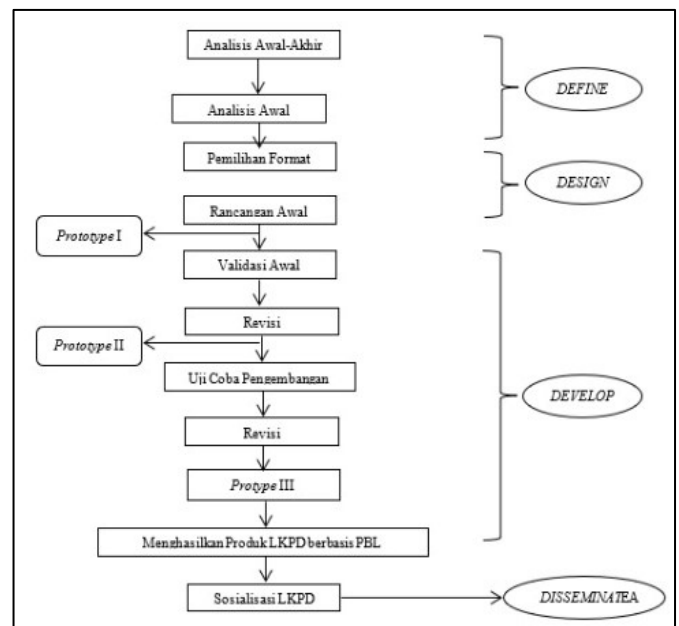


Figure 1. Teaching material development Stage (Thiagarajan et al., 1974)

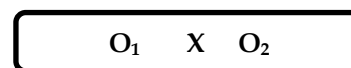


Figure 2. Research Trial Design

Information:

- O1 : Pre-test
- X : Treatment (given learning with PBL-oriented worksheets)
- O2 : Post-test

To determine the level of relevance by experts, the analysis used is the content validation coefficient or Aiken V. with the following formula:

$$V = \frac{\sum S}{n(c-1)} \tag{1}$$

Information:

- V : Index of expert agreement regarding item validation
- s : The difference in the score determined by each expert with the lowest score in the category used
- r : r-Io
- r : Rater set score
- Io : The lowest rating score
- n : The number of experts
- c : The highest validity rating score

With the Aiken test conditions, the value of  $V \geq 0.4$ , the rater agreement index (V) can be said to be valid.

The questionnaire sheet given to practitioners contains questions by selecting one of the alternative answers using a Likert scale. The Likert scale that

respondents can choose is shown in table 1 (Sugiyono, 2013).

**Table 1.** Practitioner Questionnaire Likert Scale

Category	Score Each Statement
Strongly Agree	4
Agree	3
Disagree	2
Strongly Disagree	1

The steps for determining the practitioner's response criteria for all items with the following interpretation criteria:

**Table 2.** Criteria for Interpretation of Practitioner/Educator Assessment Scores

Total Score of Respondents	Category
22 - 44	Very low
45 - 61	Low
62 - 78	Medium
79 - 95	High
96 - 112	Very high

The effectiveness of using teaching materials in the form of PBL-oriented student worksheets can be seen through tests of critical thinking skills of class X MIPA students of SMAN 22 Makassar by calculating the percentage of critical thinking skills test scores:

$$P = \frac{\sum x}{\sum x_i} \times 100\% \tag{2}$$

Information:

- P : Percentage of score acquisition
- $\sum x$  : The total score of the items
- $\sum x_i$  : Sum of ideal scores (maximum score)

Each value obtained by students is then grouped according to the critical thinking skills score criteria as shown in the following table:

**Table 3.** Criteria for Critical Thinking Skills Test Scores

Score	Criteria
0 - 3	Very low
4 - 7	Low
8 - 11	Medium
12 - 15	High
16 - 20	Very high

The effectiveness of PBL-oriented worksheets can be seen from the data from the pretest-posttest results of students' critical thinking skills. To show the increase, the N-gain formula is used as follows:

$$\text{Normalized Gain (G)} = \frac{X_{\text{Posttest}} - X_{\text{Pretest}}}{X_{\text{Max}} - X_{\text{pretest}}} \tag{3}$$

Information:

- g : Gain score is normalized
- $X_{\text{Pretest}}$  : Pretest scores

- $X_{\text{Posttest}}$  : Posttest score
- $X_{\text{Max}}$  : Maximum score

The N-gain criteria are categorized based on the following table:

**Table 4.** N-Gain Criteria (Sundayana, 2016)

N-Gain Value	Interpretation
$0.70 < g \leq 1.00$	High
$0.30 < g \leq 0.70$	Medium
$0.00 < g \leq 0.30$	Low
$g = 0.00$	No increase
$-1.00 \leq g < 0.00$	There was a decline

## Result and Discussion

The results of the PBL-oriented student worksheet validation analysis results can be seen in the following table:

**Table 5.** Validation Analysis of PBL-Oriented Student Worksheets

Aspect	Total Score	Item Validity	V	Category
Fill	7.67	0.77	0.77	Valid
Presentation	3.11	0.78	0.78	Valid
Language	7.78	0.78	0.78	Valid
Graphics	6.11	0.76	0.76	Valid

Based on the results of the analysis above, it was found that the rater agreement index (V) on the average value of the content aspect was 0.77, the presentation aspect was 0.78, the language aspect was 0.78 and the rater agreement index (V) was on the average aspect value graph of 0.76. This means that all indicators assessed in the validation process of PBL-oriented student worksheets are declared valid according to the requirements of Aiken's value formulation with a value of  $V \geq 0.4$ . So that the worksheets of PBL-oriented students are declared valid based on the assessment of experts/experts. Practitioners' assessment of PBL-oriented student worksheets is then tabulated in the following table:

**Table 6.** Analysis of Practitioners' Assessment of the Development of PBL-Oriented Student Worksheets

Number	Teacher/ Practitioner Assessment									
	1	2	3	4	5	6	7	8	9	10
1	4	3	4	4	4	4	4	4	4	4
2	4	4	3	4	3	4	4	4	4	3
3	4	4	4	4	4	3	4	3	4	3
4	4	4	4	3	4	4	4	3	4	3
5	3	4	4	4	4	4	4	4	4	4
6	3	4	4	4	4	4	4	4	4	4
7	3	3	4	4	4	4	4	4	4	4
8	3	4	4	4	4	4	4	4	4	4
9	4	4	4	4	4	4	4	4	4	4
10	4	3	4	4	4	4	4	4	4	4
11	4	4	4	4	4	4	4	4	4	4

Number	Teacher/ Practitioner Assessment									
	1	2	3	4	5	6	7	8	9	10
12	3	4	4	4	4	4	4	4	3	4
13	3	3	4	4	4	4	4	4	4	4
14	4	4	4	4	4	4	4	4	4	3
15	4	4	4	4	4	4	4	4	3	4
16	4	4	3	4	4	4	4	4	4	4
17	4	4	4	4	4	4	4	4	4	4
18	3	4	4	4	4	3	4	4	3	4
19	4	3	3	4	4	4	4	3	4	3
20	4	4	4	4	3	4	4	4	3	4
21	3	4	4	4	4	4	4	4	4	4
22	4	4	4	4	4	4	4	4	4	4
23	4	4	4	4	4	4	4	4	3	4
24	4	4	4	4	4	4	4	4	4	4
25	3	4	4	4	4	4	4	4	4	4
26	4	4	4	4	4	4	4	4	3	4
27	4	4	4	4	4	4	4	4	4	4
28	4	4	4	4	4	4	4	4	3	4
Total	103	106	110	111	110	110	112	109	105	106

Based on the Table 6, all practitioners' questionnaire scores (10 educators) are in the interval 96-112. In this way, the practitioner's questionnaire assessment of the PBL-oriented student worksheets was declared feasible.

Pre-test and post-test results were analyzed using N-gain to see an increase in students' critical thinking skills after using problem-based learning-oriented student worksheets. The results of the analysis are

presented in the form of a bar chart. Based on the results of the analysis, it was found that most of the students' critical thinking skills experienced an increase from the tests before and after the use of problem-based learning-oriented student worksheets. The results of the N-gain analysis can be seen in Figure 3.

As a result, students who experienced an increase in critical thinking skills in the high category were 15 students, in the medium category were 12 students, and in the low category were 9 people. In addition, there was no increase in the category and a decrease in each by 1 student. Overall, the average N-gain pre-test and post-test critical thinking skills of class X MIPA students at SMAN 22 Makassar was 0.51 in the moderate category. Based on this, it can be said that there is an increase in critical thinking skills for class X MIPA SMAN 22 Makassar in the medium category.

The results of this study are in accordance with some of the results of previous studies, which state that problem-based learning models can improve high-level learning outcomes. Hmelo-Silver et al. (2006) states, the problems that arise during problem-based learning do not have one answer or do not have a single answer. That is, students must be involved in exploration with several paths of solutions. Student participation in learning can help develop critical thinking skills and be fully involved in the learning process.

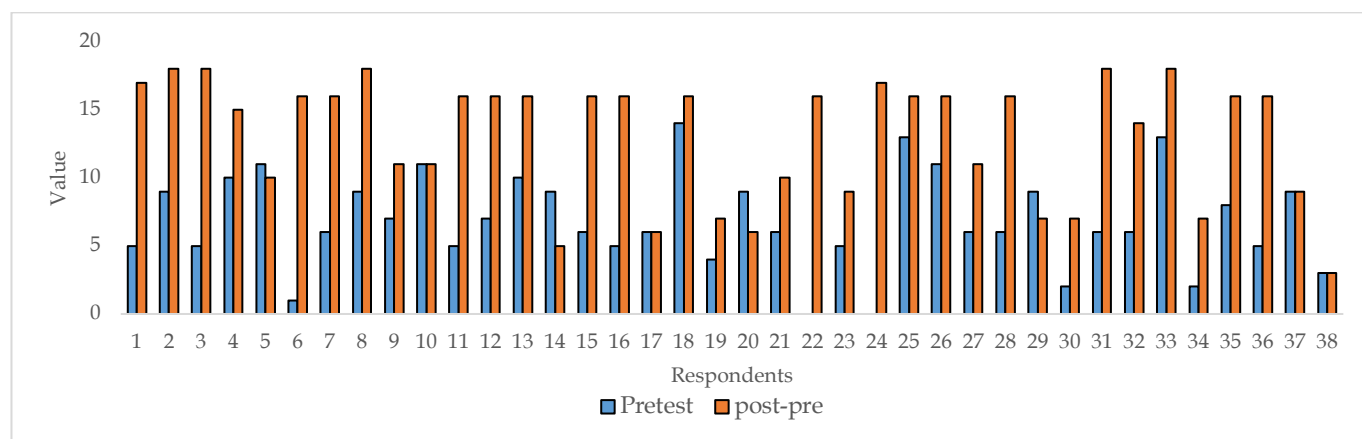


Figure 3. Pre-test and post-test of critical thinking skills

In addition, the participation of students in problem solving activities will also enable students to develop their critical thinking skills. Chen (2013) states, problem-based learning is effective in helping students in the learning process. In problem-based learning, students acquire creative thinking skills and professional skills.

**Conclusion**

Based on the research that has been done, it can be concluded that the results of the content validity coefficient test, the developed PBL-oriented student worksheets have met the valid category. Practitioners'

responses to the developed PBL-oriented student worksheets gave positive responses with very high categories. The application of PBL-oriented student worksheets seen from the critical thinking skills of students stated that there was an increase in the critical thinking skills of class X MIPA students of SMAN 22 Makassar which was analyzed using N-Gain which was in the medium category.

**Acknowledgements**

Thank you to the thesis supervisor who has guided this literature study to completion. Thanks to Prof. Dr. Hj.

Bunga Dara Amin as supervisor I and Dr. Hj. Salamang Salmiah Sari, M.Pd. as supervisor II for the knowledge that has been shared and provided the opportunity to complete the thesis well. Thanks to the University of Mataram for facilitating the creation of this article. Thanks to parents, siblings and friends in arms for their prayers, cooperation and support.

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