The Development of Physics Learning Tools with Problem-Based Learning Models to Improve Students' Critical Thinking Skills

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Received: 2nd January 2024; **Accepted**: 12th June 2024; **Published**: 15th June 2024
DOI: https://dx.doi.org/10.29303/jpft.v10i1.4621

Abstract *- The problems that are still encountered in physics learning are related to the role of the teacher who still dominates during the learning, causing students to become less active and students' critical thinking skills to become low. This study aims to determine the feasibility of physics learning tools developed using a problem-based learning model designed to improve students' critical thinking on harmonious vibration material. The research method used is Research and Development (R&D) with a 4D type of research. The instrument used is in the form of a validation sheet filled out by one expert lecturer and three Physics Education students. The results of the validation sheet are analyzed using the Likert scale technique and then categorized in the cumulative score range of product eligibility. The results of the research obtained through aspect tests on the learning tools show that the physics learning tools developed using problem-based learning models on harmonious vibration materials is very feasible to be used as an alternative to learning with presentations that can improve students' critical thinking skills. For further research, the products developed can be put through the next stage of development, namely the limited trial stage to find out their validity and empirical reliability. Then, they can be put through the effectiveness trial stage to find out whether they can be used in in schools.*

Keywords*: Learning Tools; Problem-Based Learning; Critical Thinking Skills*

INTRODUCTION

Thinking skills are one of the life skills that need to be developed through the educational process. Thinking skills can improve the processing intelligence of life skills, one of which is critical thinking skills. Critical thinking is a learning ability that must be taught to students because the results of critical thinking skills, combined with the knowledge gained by students, will be very useful for students' future lives (Sulardi et al, 2015). Therefore, the critical thinking skills of learners become one of the focuses that must be achieved in learning.

Research conducted by Sulardi et al,. (2015) suggests that students' ability to analyze various physics problems using thinking skills is still low. Then, research conducted by Jiniarti (2019) suggests that students find it difficult to understand concepts and solve a problem related to physics material. From the results of observations made by Widaningrum & Sukardiyono (2021), it is known that almost all learning tools made by educators make use of conventional learning models and in the learning process students are less active because learning is teacher-centered (Teacher Centered Learning). This is one of the problems that causes students not to be equipped with activities to improve critical thinking skills in physics learning.

In learning physics, understanding the concepts and answering questions are not enough. Learning physics requires students to practice developing the ability to conduct experiments and think critically (Widaningrum & Sukardiyono, 2021). Learning physics cannot be separated from the problem-solving process (Jiniarti, 2019).

Therefore, it is necessary to develop a learning model that can make students more active at the time of learning in order to improve their critical thinking skills. There are many approaches, strategies, methods and models that can be applied to train students' critical thinking skills in learning, one of which is the problem-based learning model.

The essence of problem-based learning is to present students with authentic and meaningful problematic situations, which serve as a springboard for student investigation. Problem-based learning seeks to help students to become independent and self-regulated learners. Guided by teachers who are always encouraging and rewarding them when asking questions and finding their own solutions to various real problems, students will later learn to carry out their duties independently (Sulardi, 2015). During problem-based learning model activities, students become the main figures who are directly involved in learning, not just passive listeners to all the information conveyed by the teacher. Problem-based learning conditions students to learn to interact with groups, associates learning with other materials, and trains students to do inquiries, find appropriate problem-solving ways and think critically.

Problem-based learning is in line with physics learning because problem-based learning provides stages for students to be able to solve physics problems that exist in everyday life based on physics concepts. Previous research conducted by Aripin et al (2021) suggests that physics learning tools that use problem-based learning effectively and efficiently improve students' problem-solving and critical thinking skills. These previous problems and research thus serve as a consideration for researchers in developing physics learning tools using problem-based learning models to improve students' critical thinking skills. This tool is expected to be an alternative choice in carrying out physics learning to improve students' critical thinking skills.

RESEARCH METHODS

The method used in this article is R&D (Research and Development) and the type of research used is the 4D type. The 4D procedure in this study is:

1. Define

The first stage that is carried out is the define stage. At this stage, literature studies are carried out by analyzing the problems encountered in the learning process and investigating the factors that cause these problems so that it is necessary to develop learning tools. The problems discovered were that almost all learning tools made by educators used conventional learning models and that students were less actively involved in the learning process because the learning was teacher-centered, resulting in a condition where there was only very little critical thinking process involved in students' learning physics. Based on this, the researcher concluded that it is necessary to develop learning tools in the form of lesson plan (hereinafter RPP), student worksheet (hereinafter LKPD), and assessment instruments using problem-based learning in order to improve students' critical thinking skills.

2. Design

The second stage is the design stage, at which stage a product design on harmonious vibration materials will be developed in the form of RPP, LKPD, and assessment instruments. The stages carried out on the design of the RPP, LKPD, and assessment instruments are (1) determining what content will be used in the RPP, LKPD, and assessment instruments, (2) collecting

material related to harmonious vibrations from various accurate reference arrangements, (3) preparing the RPP and LKPD designs which contain the elaboration of objectives, core competencies, basic competencies, indicators, and the activities that will be displayed, following the steps of problem-based learning. In the preparation of LKPD, the LKPD is designed as attractive as possible by combining, letters, layout, colors, and drawings that are in accordance with the material, (4) preparing assessment instruments related to harmonious vibration material by following learning indicators accompanied by drawings.

3. Development

The third stage is the development stage, at which stage a product feasibility test is carried out to determine the feasibility of the learning tools in the form of RPP, LKPD, and assessment instruments developed. The feasibility test assessment was carried out by one physics education lecturer and three physics education students. Feasibility test data collection is carried out using a Microsoft Word document with a Likert Scale in which there are aspects assessed in the RPP in the form of aspects of RPP identity, Basic Competencies, subject matter, activities/steps, assessments, time allocation, learning resources, and language. For LKPD, the aspects assessed include aspects of content feasibility, presentation, graphics and sources, and language. Then, for the assessment instrument, the aspects assessed encompass content, construction, and language.

4. Dissemination

The final stage is the dissemination stage. The purpose of this stage is disseminating the research products in the form of physics learning tools using problem-based learning models that have been developed. The dissemination stage is carried out by making scientific articles of the research results, which are then distributed in the form of e-journals.

To determine the feasibility of the learning tools, Likert scale is used to analyze the validity of the learning tools. The validity of the learning tools developed was analyzed using the following equations (Sugiyono, 2013):

$$P = \frac{f}{n} \times 100\% \quad (1)$$

Note:
P: Percentage earned
f: Raw score obtained
n: The ideal maximum score

The percentage results are then converted into the following learning tools' validity criteria:

Table 1. Eligibility level qualification based on average percentage

Level of achievement	Qualification
80% – 100%	Highly Valid
60% – 79.9%	Valid
50% – 59.99%	Less Valid
0% – 49.99%	Invalid

Source: Latifah, 2016.

RESULTS AND DISCUSSION

The results of the feasibility test assessment of the development of learning tools in this study were carried out by one physics education lecturer and three physics education students. Then, the results of the feasibility test assessment were analyzed by referring to Sugiyono feasibility test (2013). Here, the feasibility test results for the development of the learning tools in the form of RPP, LKPD, and assessment instruments using problem-based learning are shown in Table 2.

Table 2. RPP Feasibility Test Qualifications for Each Aspect

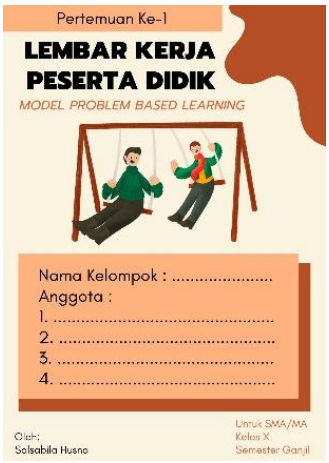
Aspects	Validator (Lecturer)	Validator (Student)	Average	Category
RPP Identity	100%	95.83%	97.90%	Highly Valid
Basic Competencies	87.50%	87.50%	87.50%	Highly Valid
Subject Matter	75%	77.78%	76.39%	Valid
Activities	75%	80.56%	77.78%	Valid
Assessment	62.50%	66.67%	64.6%	Valid
Time Allocation	75%	75%	75%	Valid
Learning Resources	75%	83.30%	79.15%	Valid
Language	75%	83.30%	79.15%	Valid

Based on the results of the analysis in Table 1, when thoroughly reviewed, the aspects of the RPP that have been developed were deemed as valid. So, the RPP that has been developed can be tested in the field. This is especially true for the identity and Basic Competencies aspect of the RPP, which obtained a high average score, namely 97.9% and 87.5% respectively. Both aspects fell within the category “highly valid”.

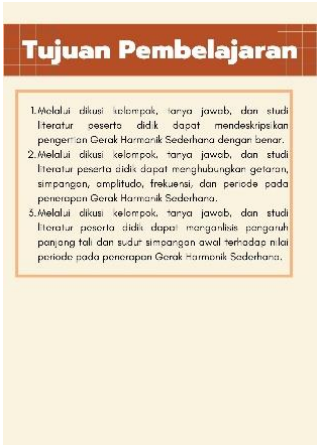
The results of the analysis on the activity aspect resulted in an average score of 77.78%, which fell within the valid category. The results of the assessment of the activity aspect suggests that the activities presented in the RPP developed using problem-based learning greatly affect student achievement in critical thinking. This is in line with research conducted by Widaningrum & Sukardiyono (2021), who said that learning physics requires students to practice developing the ability to conduct experiments and think critically (Widaningrum & Sukardiyono, 2021). Learning physics is also inseparable from the problem-solving process (Jiniarti, 2019). Furthermore, the aspect that obtained the lowest average score, but is nevertheless still categorized as valid, is the assessment aspect with an average score of 64.6%. This means that the assessment contained in the RPP developed needs to be put into details in order to display the type of assessment carried out.

As for the LKPD, the LKPD developed encompassed learning objectives and activity steps in accordance with the syntax of problem-based learning. There are five syntax in the learning process using a problem-based learning model. The display of the LKPD is as follows:

1) Initial View



2) Learning Objective View



3) Syntax View

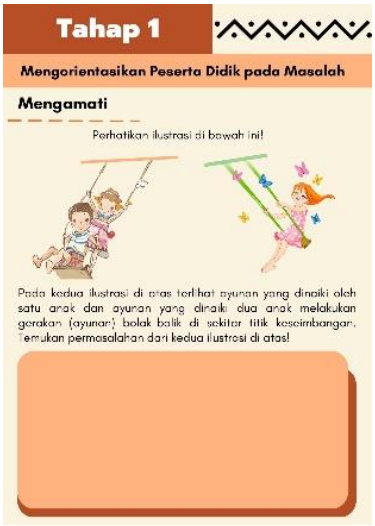


Table 3. LKPD Feasibility Test Qualifications for Each Aspect

Aspects	Validator (Lecturer)	Validator (Student)	Average	Category
Contents Feasibility	82%	83.30%	82.85%	Highly Valid
Presentation	81.25%	85.42%	83.33%	Highly Valid
Language	75%	87.5%	81.25%	Highly Valid

Based on the results of the analysis in Table 2, overall, all aspects of the LKPD that have been developed are categorized as highly valid. Thus, the LKPD that has been developed can be tested in the field. In regards with the aspect of content feasibility, one of the validators stated that overall, the content contained in the LKPD that has been developed using problem-based learning is in accordance with the learning objectives. The assessment suggests that the material presented in the products developed is very feasible to be used to measure whether or not the learning objectives are attained (Yerimadesi et al,. 2018).

The results of the analysis on the aspect of presentation are also categorized as highly valid. These results show that the illustrations and systematic collapses of the presentation used in LKPD are developed in accordance with the problems in the harmonious vibration material, so, it can attract the students' attention during the learning process (Yunalis & Bayu, 2018). Then, the results of the analysis on the language aspect also obtained very valid results. These results show that the use of language is in accordance with PUEBI (Pedoman Umum Ejaan Bahasa Indonesia). The use of language that is in accordance with PUEBI can make it easier for students to understand the material presented during the learning process (Putri & Hum, 2020).

Table 3. Assessment Instrument Feasibility Test Qualifications for Each Aspect

Aspects	Validator (Lecturer)	Validator (Student)	Average	Category
Content	100%	100%	100%	Highly Valid
Construction	68.75%	79.17%	73.95%	Valid
Language	100%	100%	100%	Highly Valid

Based on the results of the analysis in Table 3, when thoroughly reviewed, the aspects of the assessment instrument that have been developed were deemed as valid. Thus, the assessment instruments that have been developed can be tested in the field. This is especially true for the aspect of content and language, which obtained a high average score, 100%. Both aspects fell within the category highly valid. The results of the assessment on the content aspect indicate that the content in the assessment instrument greatly affects the results of the learning process, especially related to the results of student scores (Sudjana, 2010). Then, the results of the analysis on the Language aspect show that the language used is in accordance with PUEBI (*Pedoman Umum Ejaan Bahasa Indonesia*) and the sentences are easy-to-understand.

The analysis on the construction aspect obtained an average of 73.95%, which is categorized as valid. These results suggest that the construction of the assessment instruments will have a direct

effect on the accuracy of the attainment of student learning outcomes (Ardhianti & Ishafit, 2018). One of the validators stated that the it is important that the developers be consistent in making the choices of answer in multiple choice question, to make it as valid as possible is to use almost the same or homogeneous choice so that there is a distractor effect on students.

The RPP developed using problem-based learning on harmonious vibration materials get feasibility test results for the aspects of RPP identity, Basic Competencies (KD), subject matter, activities/steps, assessment, time allocation, learning resources, and language. In LKPD, the aspects assessed are content feasibility, presentation, graphics and sources, and language. Then, in the assessment instrument, the aspects assessed are content, construction, and language, all of which are classified as very feasible. The development of this learning tool is also strengthened by previous research conducted by Aripin et al,. (2021) which suggests that physics learning tools that use problem-based learning models effectively and efficiently improve students' problem-solving skills and critical thinking skills. Therefore, the RPP, LKPD, and Assessment Instruments developed using problem-based learning on harmonious vibration materials is very feasible to use.

The implication of this study is that the product can be put through the next stage of development, namely the limited trial stage, to determine its validity and empirical reliability, and the effectiveness trial stage, to find out whether or not the RPP, LKPD, and Assessment Instruments developed is effective to be used in schools. The results obtained from the two stages will show that the RPP, LKPD, and Assessment Instruments developed using problem-based learning is feasible and effective, so that it can be applied in schools.

CONCLUSION

Based on the results of the analysis that has been carried out, it can be concluded that the development of learning instruments in the form of RPP, LKPD, and Assessment Instruments using problem-based learning on Harmonic Vibration material is very feasible to be used to improve the critical thinking skills of students. The discovery in the development of this learning tool is that the product can be used to measure the implementation of learning in achieving learning objectives, can cause a sense of attention of students, and can minimize misconceptions because the use of language in the learning tool developed is in accordance with PUEBI (*Pedoman Umum Ejaan Bahasa Indonesia*).

ACKNOWLEDGMENT

We would like to express our gratitude to the Department of Physics Education, FMIPA, Universitas Negeri Yogyakarta.

REFERENCES

Ardhianti, S., & Ishafit, I. (2018, May). Pengembangan Instrumen Penilaian Kemampuan Berfikir Kritis pada Pembelajaran Fisika SMA. *In Quantum: Seminar Nasional Fisika, dan Pendidikan Fisika*. 575-582.

Aripin, W. A., Sahidu, H., & Makhrus, M. (2021). Efektivitas Perangkat Pembelajaran Fisika Menggunakan Model Problem Based learning untuk Meningkatkan Kemampuan Pemecahan Masalah dan Kemampuan Berpikir Kritis Peserta Didik: *Jurnal Penelitian dan Pembelajaran Fisika Indonesia. 3*(1), from https://doi.org/10.29303/jppfi.v3i1.120

Latifah, S. (2016). Pengembangan Lembar Kerja Peserta Didik (LKPD) Berorientasi Nilai-nilai Agama Islam Melalui Pendekatan Inkuiri Terbimbing pada Materi Suhu dan Kalor: *Jurnal ilmiah pendidikan fisika Al-Biruni*, *5*(1), 43-51, from https://doi.org/10.24042/jipfalbiruni.v5i1.104

Putri, N. P., & Hum, S. (2019). Media Luar Ruang di Pacitan. *Seminar Nasional: Hasil Penelitian dan Abdimas*, 120. Retrieved from https://lppm.stkippacitan.ac.id/wp-content/uploads/2022/02/PROSIDING-SEMNAS-2019-New.pdf#page=128

Sudjana, N. (2010). *Penilaian Hasil Proses Belajar Mengajar*: UPT Perpustakaan IAIN Palangka Raya.

Sugiyono. (2013). *Metode Penelitian Pendidikan: Pendekatan Kuantitatif, Kualitatif, dan R&D*. Bandung: Penerbit Alfabeta.

Sulardi, S., Nur, M., & Widodo, W. (2015). Pengembangan Perangkat Pembelajaran Fisika Model Problem Based Learning (PBL) Untuk Melatih Keterampilan Berpikir Kritis Siswa: *JPPS (Jurnal Penelitian Pendidikan Sains)*, 5(1), 802-810 from https://doi.org/10.26740/jpps.v5n1.p802-810

Widaningrum, R., & Sukardiyono, S. (2021). Pengembangan Perangkat Pembelajaran Model Online-Project Based Learning untuk Meningkatkan HOTS Fisika Peserta Didik SMA: *Jurnal Pendidikan Fisika*, 8(1).

Yerimadesi, Y., Bayharti, B., & Oktavirayanti, R. (2018). Validitas dan Praktikalitas Modul Reaksi Redoks dan Sel Elektrokimia Menggunakan Guided Discovery Learning untuk SMA: *Jurnal Eksakta Pendidikan (JEP)*, 2(1), 17-24 from https://doi.org/10.24036/jep/vol2-iss1/143

Yunalis., & Bayu, E. P. S. (2018). Validitas Lembar Kerja Siswa (LKS) Menggunakan Discovery Learning Pada Materi Bangun Ruang Sisi Datar: *Lemma*, 5(1), 1-5.