

## Development of physics learning materials on temperature and heat topics using problem-based learning models to improve students' conceptual understanding

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### Abstract

The use of appropriate learning tools, one of which is in the form of lesson plans, worksheets, and assessment instruments using the Problem-Based Learning (PBL) model, is considered to be able to improve students' understanding of concepts. This is due to the low understanding of students' concepts in physics learning on Temperature and Heat material which is caused by the inaccuracy of the selection of learning tools and models used in classroom learning. Based on this, the purpose of this study is to determine the feasibility of physics learning devices on Temperature and Heat material by using the Problem-Based Learning model to improve students' understanding of concepts. The research design uses the 4D research and development model which consists of four stages, namely defining, designing, developing, and disseminating. Due to time constraints in conducting research, this research was only carried out until the development stage. This study used instruments in the form of three validation sheets which included validation sheets of RPP, LKPD, and assessment instruments given to four validators. The validators chosen to assess the learning tools that have been developed include one expert validator (Physics Education Lecturer) and three peer validators (Physics Education undergraduate students). Data analysis used in this study is validation analysis using a Likert scale. The results of this study indicate that the physics learning device on the subject of Temperature and Heat uses the Problem-Based Learning model to increase students' understanding of the concepts that have been developed which are stated to be very feasible to use. The average value obtained in the lesson plan validity test was 87.23%, the LKPD validity test was 84.17%, and the assessment instrument validity test was 81.11%.

**Keywords:** Understanding Concepts · Learning Tools · Problem Based Learning (PBL) · Temperature and Heat

### INTRODUCTION

In the era of revolution 4.0 there was intense competition where it was necessary to increase human resources, this was inseparable from the world of education in Indonesia. Improvements

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that can be made are by increasing the learning outcomes of students and changing learning strategies and models in accordance with the times. One of the subjects that plays an important role in improving human resources is physics because physics contains logical and realistic concepts that play a role in shaping the human mindset in developing science and technology.

Learning physics in the classroom, in fact, there are still problems that affect the mindset of students towards learning physics. Many students still perceive physics as learning that is less meaningful and less useful. This is due to a lack of understanding of the concept so that students cannot relate the physics learning that has been carried out with events that occur in the surrounding life. Even though the definition of physics is the science that studies the natural world and the phenomena that occur there. One of the misconceptions or lack of understanding of physics concepts occurs in the material Temperature and Heat. This misconception is quite high (Mustika, et al. 2020) indicating that the learning process has not been able to make students master the material concepts well. As one example, namely students who have not been able to distinguish the definition between temperature and heat.

Conceptual understanding is a student's ability to master a number of materials, where students not only know and remember, but are also able to re-express, interpret, and apply the concepts they have learned. Understanding the concept is an important part of the learning process and solving problems. The indicators of understanding the concept according to Hamza (2016) include students being able to 1) restate a concept, 2) classify objects according to the concept, 3) give examples and not examples of a concept, 4) present concepts in the form of mathematical representations, 5) develop the necessary and sufficient requirements of a concept, 6) use, utilize, choose certain procedures, and 7) apply concepts or solve problems.

In the process of learning physics so that students can improve their understanding of concepts, especially in the material Temperature and Heat, the teacher must have a strategy in choosing the learning methods and models to be used. One of the learning tools that can help students and teachers in the learning process is LKPD (Student Work Sheets) and RPP ( Learning Plans) along with their assessment instruments. The learning model that can be used is Problem-Based Learning (PBL).

Problem-Based Learning learning model is learning that emphasizes problem-solving activities. In the learning process, the teacher is only a mediator and facilitator to help students in the process of building knowledge actively, while students are required to participate in learning actively and must be able to find answers to the problems that have been given by the teacher. The steps for Problem-Based Learning are 1) student orientation to problems, 2) organizing students for learning, 3) guiding individual or group experiences, 4) developing and presenting results, and 5) analyzing and evaluating the learning process.

The learning device developed in this study is different from previous research, namely focusing on the learning material for Temperature and Heat and the learning model used, namely Problem-Based Learning (PBL). The development of learning tools in the form of LKPD and RPP along with assessment instruments using the Problem Based Learning model and scientific approach is expected to be able to assist the learning process of students in increasing understanding of concepts in the material Temperature and Heat. In addition, it is hoped that through increasing understanding of the concepts carried out in learning physics can change the mindset of students towards learning physics which is not difficult, but meaningful and useful. The purpose of this study is to determine the feasibility of physics learning devices

on Temperature and Heat material using the Problem-Based Learning model to improve students' understanding of concepts.

## METHODS

This research uses the type of research and development or Research and Development (R&D). The purpose of this type of research is to develop and obtain validation of an educational product (Setyosari, 2016). The development model used in this R&D research procedure is the 4D development model. There are four stages in the 4D model among them define, design, develop, and disseminate. There is limited time in conducting research, so the research procedure used only reaches the development stage.

This study used a data collection instrument in the form of validation sheets with a total of three sheets given to four validators including one expert validator, a Physics Education Lecturer and three peer validators, namely Physics Education undergraduate students. The four validators are considered to have experience in the field of developing physics learning tools. The validation sheet for assessing learning tools consists of one RRP validation sheet, one LKPD validation sheet, and one assessment instrument validation sheet. The data analysis technique used in this study is validity analysis using a scale Likert. It aims to determine the feasibility of learning tools that have been developed. The following equations are used for data analysis.

$$P = \frac{f}{n} \times 100\% \tag{1}$$

$P$  is the percentage of validity obtained,  $f$  is score obtained,  $n$  total score. After finding the percentage of the calculation results, it is converted in the form of eligibility criteria or the validity of the learning tools presented in Table 1 (Latifah, 2016).

**Table 1** . Criteria for Feasibility/Validity of Learning Media

Percentage (%)	Eligibility/Validity
0 – 49.99	Not feasible
50.00 – 59.99	Less Worthy
60.00 – 79.99	Worthy
80.00 - 100	Very Worth it/feasible

## RESULT AND DISCUSSION

### Definition

Based on the results of the literature, it was found that the learning process currently carried out uses the 2013 curriculum (K-13) with less varied learning models. During learning activities, there are several problems that arise in the physics learning process, including the methods, models, and learning media used. This makes students have the mindset that physics is learning that is less meaningful and less useful. This mindset arises due to a lack of understanding of concepts in learning physics, especially in the subject of Temperature and Heat. Based on this, it is necessary to have an appropriate learning strategy to improve students' understanding of concepts in learning physics, especially on the material Temperature and Heat.

**Design**

At this stage, the initial design of the learning device that will be developed is carried out. The learning tools developed are in the form of LKPD and RPP along with assessment instruments using the Problem-Based Learning (PBL) model on Temperature and Heat material.

The RPP design begins with a learning implementation plan using the Problem-Based Learning model. RPP contains learning objectives, Core Competencies (KI), Basic Competencies (KD), Competency Achievement Indicators (GPA), concept maps of temperature and heat material, learning strategies, learning media, learning resources, and guide steps and time allocation in learning. In the core activities, there is a series of learning using the Problem-Based Learning model and a scientific approach. The following is a display of the developed RPP.

RENCANA PELAKSANAAN PEMBELAJARAN (RPP)	
Sekolah	: SMA XXX
Mata pelajaran	: Fisika
Kelas/Semester	: XI MIPA/1
Materi Pokok	: Perpindahan Kalor
Alokasi Waktu	: 3 x 45 menit
KOMPETENSI INTI	
Kompetensi inti	
Sikap (KI 1 dan KI 2)	KI 1 : Menghayati dan mengamalkan ajaran agama yang dianutnya.  KI 2 : Mengembangkan perilaku (jujur, disiplin, tanggungjawab, peduli, santun, ramah lingkungan, gotong royong, kerjasama, cinta damai, responsif dan proaktif) dan menunjukkan sikap sebagai bagian dari solusi atas berbagai permasalahan bangsa dalam berinteraksi secara efektif dengan lingkungan sosial dan alam serta dalam menempatkan diri sebagai cerminan bangsa dalam pergaulan dunia.
Pengetahuan (KI 3)	KI 3 : Memahami, menerapkan, dan menganalisis pengetahuan faktual, konseptual, prosedural, dan metakognitif berdasarkan rasa ingin tahunya tentang ilmu pengetahuan, teknologi, seni, budaya, dan humaniora dengan wawasan kemamusiaan, kebangsaan, kenegaraan, dan peradaban terkait penyebab fenomena dan kejadian, serta menerapkan pengetahuan prosedural pada bidang kajian yang spesifik sesuai dengan bakat dan minatnya untuk memecahkan masalah.
Keterampilan (KI 4)	KI 4 : Mengolah, menalar, dan menyaji dalam ranah konkret dan ranah abstrak terkait dengan pengembangan dari yang dipelajarinya di sekolah secara mandiri, bertindak secara efektif dan kreatif, serta mampu menggunakan metode sesuai kaidah keilmuan

**Figure 1.** Display of the first page lesson plans

LANGKAH PEMBELAJARAN				
<b>Pertemuan ke 4 (3 x 45 menit)</b> Indikator pembelajaran: 1. Menjelaskan peristiwa perpindahan kalor secara konduksi, konveksi, dan radiasi. 2. Membandingkan peristiwa perpindahan kalor secara konduksi, konveksi, dan radiasi. 3. Mengidentifikasi faktor-faktor yang mempengaruhi perpindahan kalor.				
Keterangan fase <i>Problem Based Learning</i> dan pendekatan saintifik	Fase pembelajaran		Karakter	Alokasi Waktu
	Guru	Peserta didik		
<b>Kegiatan Pendahuluan</b>				
	<ul style="list-style-type: none"> <li>Mengucapkan salam.</li> <li>Meminta ketua kelas memimpin doa sebelum pelajaran dimulai.</li> <li>Mengecek kehadiran peserta didik</li> <li>Mengkondisikan kelas dan membuat kesepakatan.</li> <li>Memberikan apersepsi untuk memotivasi peserta didik dengan demonstrasi tentang materi yang akan diajarkan.</li> </ul>	<ul style="list-style-type: none"> <li>Menjawab salam.</li> <li>Ketua kelas memimpin doa.</li> <li>Menjawab berdasarkan nama yang dipanggil.</li> <li>Mempersiapkan diri untuk mengikuti pembelajaran.</li> <li>Peserta didik menemukan ide-ide baru.</li> <li>Menjawab pertanyaan guru.</li> </ul>	Religius  Tanggungjawab  Disiplin  Kreatif Berani Rasa ingin tahu Kreatif	15 menit

**Figure 2.** Display of the lesson plan lesson plan section

LKPD designs are prepared according to the learning objectives in accordance with the *Problem-Based Learning model* and the Scientific approach. LKPD contains learning objectives, Basic Competency (KD), Achievement Indicators. Competence (GPA), motivation to learn, practicum guide steps, and sheets to answer the questions that have been provided. The following is a display of the developed LKPD.

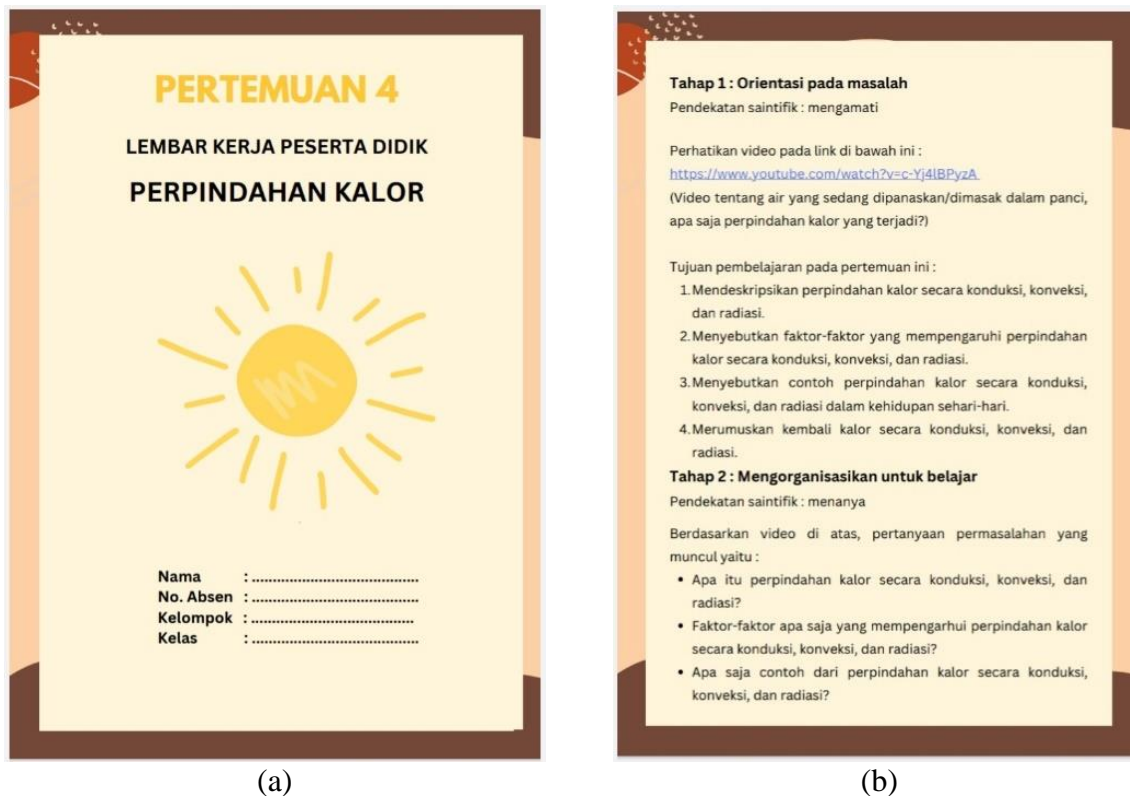


Figure 3. (a) LKPD display on the cover, (b) Display of the material section of the LKPD

The design of the assessment instrument was prepared for cognitive, affective and psychomotor learning outcomes. The instrument is arranged by paying attention to the minimum cognitive domain that must be achieved by students. The contents of the assessment instrument are indicators, indicator questions, questions, answers, and the cognitive domain. The following is a display of the assessment instrument developed.

INSTRUMEN PENILAIAN				
Indikator	Indikator Soal	Soal	Jawaban	Ramah
Menjelaskan peristiwa perpindahan kalor secara konduksi, konveksi, dan radiasi.	Siswa menganalisis perbedaan dari peristiwa perpindahan kalor secara konduksi, konveksi, dan radiasi.	Analisislah perbedaan dari peristiwa perpindahan kalor secara konduksi, konveksi, dan radiasi!	Perbedaan antara ketiganya yaitu terletak pada medium dan disertai atau tidaknya zat perantara yang digunakan oleh kalor untuk berpindah. <b>Konduksi atau hantaran</b> Konduksi adalah perpindahan kalor melalui suatu zat petantara atau medium tanpa disertai perpindahan zat perantaranya. <b>Konveksi atau aliran</b> Konveksi adalah perpindahan kalor melalui zat perantara atau medium, dan disertai perpindahan mediumnya. <b>Radiasi atau pancaran</b> Radiasi adalah perpindahan kalor tanpa melalui medium.	C4
Membedakan penerapan peristiwa perpindahan kalor secara konduksi, konveksi, dan radiasi dalam kehidupan sehari-hari.	Siswa mengklasifikasikan penerapan kalor dalam kehidupan sehari-hari.	Diantara penerapan perpindahan kalor dalam kehidupan sehari-hari berikut, klasifikasikan mana yang termasuk konduksi, konveksi, dan radiasi!	<b>Penerapan konduksi</b> 13) Memasak air menggunakan panci logam 14) Membuat kopi atau minuman panas 15) Membakar besi logam dan sejenisnya 16) Solder 17) Setrika listrik <b>Penerapan konveksi</b> 1) Terjadinya angin laut dan angin darat	C3

Figure 5. Appearance of Assessment Instruments



### Development Stage (Development)

After carrying out the previous two stages, learning tools are produced that are in accordance with the Problem-Based Learning learning model to increase students' conceptual understanding of the material Temperature and Heat. The next stage is to conduct a validation test or test the feasibility of learning devices by four validators. There is one expert validator, namely the Physics Education Lecturer and three peer validators, namely Physics Education undergraduate students . From the validation test or feasibility test of learning tools that have been developed, the results are as shown in Table 2.

**Table 2.** Validity/Feasibility Test by Validators

Device	Average Percentage		Information
	Expert Validator	Peers Validator	
RPP	86.67%	87.78%	Feasible
LKPD	78.33%	90%	Feasible
Assessment Instrument	73.33%	88.89%	Feasible

### Discussion

In this research, learning tools were developed in the form of LKPD and RPP along with assessment instruments based on the Problem-Based Learning model to improve students' conceptual understanding of the material Temperature and Heat. In the validity test or feasibility test the developed learning device is carried out based on the Likert scale. The assessment was carried out by four validators including one expert validator, namely a Physics Education Lecturer, and three peer validators, namely Physics Education undergraduate students.

The RPP developed is based on the Problem-Based Learning learning model and a scientific approach to temperature and heat. The RPP developed is one of the meetings that focuses on the Heat Transfer sub-material which is expected to achieve the learning objectives. Based on table 2, the developed lesson plan is included in the very feasible category with an average percentage obtained from expert validators of 86.67% and peer validators of 87.78%. This shows that the RPP developed is stated to be very feasible to use.

The LKPD developed was based on the Problem-Based Learning learning model on Temperature and Heat material. The LKPD developed is one of the meetings that focuses on the Heat Transfer sub-material which is expected to achieve the learning objectives. Based on table 2, the lesson plan developed is included in the very feasible category with an average percentage obtained from expert validators of 78.83% and peer validators of 90%. This shows that the developed LKPD is declared very feasible to use.

Based on table 2, the assessment instrument developed is included in the very feasible category with an average percentage obtained from expert validators of 73.33% and peer validators of 88.89% . This shows that the developed LKPD is declared very feasible to use.

The results of the study were obtained as a whole, namely the average score on the lesson plan validity test was 87.23%, the LKPD validity test was 84.17%, and the assessment instrument validity test was 81.11%. These results are in accordance with Egista's research [2], stating that learning tools developed on Harmonic Vibration material using the Discovery Learning model are feasible to use and can improve students' mastery of concepts. The indicators of mastery of concepts that are expected to be achieved according to Hamzah (2016) include students being able to restate a concept, classify objects, provide examples and non-

examples, present concepts in the form of mathematical representations, develop necessary and sufficient conditions, use, utilize, selecting certain procedures, and applying concepts or solving problems. Based on this, the learning device on Temperature and Heat material using the Problem-Based Learning model developed can be declared feasible to use and is expected to increase students' understanding of concepts, especially on Temperature and Heat material.

## CONCLUSION

Based on the results of the validation or due diligence, the average score on the lesson plan validity test was 87.23%, the LKPD validity test was 84.17%, and the assessment instrument validity test was 81.11%. Where it can be stated that learning tools in the form of lesson plans, worksheets, and assessment instruments on Temperature and Heat materials use the Problem-Based Learning model which aims to increase students' understanding of the concepts developed which are very feasible to use. As for suggestions for further research, it is expected to be able to develop learning tools with this Problem-Based Learning (PBL) model for other physics subjects and materials.

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