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PROBLEM-BASED LEARNING OF STUDENT WORKSHEETS ON HEAT TRANSFER MATERIALS IN ELEMENTARY SCHOOL

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Abstract

The purpose of this research is to develop student worksheet of Problem Based Learning on heat transfer material in class V SDN Bakalan Krajan 2 Malang which is valid according to material experts and teaching materials experts, practical according to teachers, and interesting according to students. This product can be used as teaching materials and additional aids in KD 3.6 and 4.6 heat transfer materials. This research uses the Research and Development (RnD) method and the ADDIE development model which consists of five stages, namely analysis, design, development, implementation, and evaluation. Data collection techniques used are interviews, observations, and questionnaires. The results of the validation of material experts get an average of 94%, teaching materials experts 95.83%, practicality of student worksheet according to users get 100%, and student responses about the attractiveness of student worksheet each get 100% and 97.67%. Thus, it can be concluded that the PBL-based worksheets on heat transfer material in class V SDN Bakalan Krajan 2 Malang are very valid according to experts, practical according to teachers as users, interesting according to students and suitable for use in the learning process without revision.

Keywords: Elementary School, Heat Transfer Material, Problem Based Learning, Student Worksheet

INTRODUCTION

The development of science and technology in the 21st century is very rapid. Therefore, Indonesia needs abundant natural resources and superior human resources to compete and survive in the global era (Febrianta et.al., 2017). One of the advantages is education can improve human resources. Education is an effort planned to deepen and develop the potential and talents of students to obtain religious values, noble character, noble personality, self-control, intelligence, and skills needed as part of society (Ristekdikti, 2016). Through education, a person can develop attitudes,

knowledge, and abilities optimally. All three are aspects that are emphasized in the 2013 curriculum.

The 2013 curriculum is the curriculum currently used by Education Units in Indonesia. The 2013 curriculum changed the form of learning that the teacher initially dominated to become student-centered learning. This student-centered means that students are required to participate in the learning process by actively digging for information, finding problems, finding solutions to problems, working together, and carrying out every learning step the teacher has arranged (Lestari et.al., 2021). In this case, the teacher is no longer a learning center. Still, it only facilitates students in all learning activities so that the teacher is active in his role as a motivator and facilitator.

The teacher, as a facilitator, can provide learning facilities in the form of teaching materials. One of the teaching materials that can make learning more active and independent and can be used by teachers in the learning process is Student Activity Sheets (Aini et.al., 2019). Because student worksheet is a supporting/complementary means of learning plans that teachers in the learning process often use. In addition, student worksheet is also an activity sheet that helps students understand the material independently and facilitates the implementation of teacher teaching to students (Andi, 2011). Thus, student worksheet can be used to make it easier for students to master the material actively and independently and to make it easier for teachers to direct effective and efficient learning.

Based on the results of interviews with class VB teachers at SDN Bakalan Krajan 2 Malang on January 27, 2022, it was found that the teacher had used the student worksheet in the learning process in class. The student worksheet used also has several advantages, including: the size and type of letters are easy to read, the spacing between sentences is tight enough, the language in the student worksheet is easy to understand.

However, the student worksheet that is used still has several weaknesses,

including (a) the contents and activities of the student worksheet still contain questions that are almost the same as evaluation questions, which emphasizes more on memory questions without explaining how the process of answering these questions is obtained, (b) student worksheet activities have not invited students to participate in problem-solving activities, (c) student worksheet there are still few illustrations, so they are still simple in terms of design. In addition, during the interview, the homeroom teacher also said that the material that was considered difficult by most students and had many experimental activities was heat transfer material. According to him, students still have difficulty distinguishing between heat transfer by conduction and convection. This happens because the teacher still makes theme books the only source of learning and has never used teaching materials and other aids when delivering the material. The teacher also needs more time to conduct experimental activities on the heat transfer material.

Based on the facts obtained from the interview results, student worksheets can be used as a solution for thematic learning content, especially science content that requires experimental activities (Aini et.al., 2019). Even though science content is integrated into thematic learning such as Indonesian, social studies, civilization, and art, which become one lesson. However, the competencies that must be achieved from each lesson content remain the same. Because actually, student worksheets can be used as a tool for students to understand learning material.

Observing learning in class shows that students in class V have greater independence and responsibility for learning compared to the grade level below them. Class V students can follow the lesson well even though the teacher gives little guidance. However, students must be trained to develop process skills and scientific attitudes in learning science. In addition, students have yet to be involved in finding and solving problems in education. Meanwhile, according to (Rusman, 2015), problem-based learning activities can optimize critical thinking skills.

Problem-based learning or Problem-Based Learning (PBL) begins by presenting everyday problems, allowing students to conduct investigations necessary to solve problems (Assegaff & Sontani, 2016). PBL wants students to be able to construct their knowledge into long-term memory. Thus, the knowledge gained is not only used to solve given problems but can produce changes in behavior and mastery that are not only conceptual (Suryawan et.al., 2019). This is because PBL expects students to adopt a change in mindset from teacher dependence to independence.

Therefore, the solution to solving problems in science content learning, especially heat transfer material, is to develop PBL-based student worksheets. Problem-Based Learning based student worksheets are activity sheets whose contents include problem-based learning syntax. Student worksheets are expected to allow students to participate actively in the learning process. In addition, problem-oriented student worksheets are also expected to improve mastery of the material and help student's practice critical thinking when dealing with everyday problems.

Similar research by Lestari shows that the Problem-Based Learning model-based science student worksheets in grade IV SD can assist educators in teaching and learning activities (Lestari et.al., 2021). In addition, the student learning outcomes test on the knowledge aspect also obtained a percentage of 92.85%. This means that the PBL model-based Science student worksheets effectively change learning outcomes. Then the research conducted by Sari also produced compelling and engaging Problem-Based Learning based student worksheets to improve student's critical thinking skills (I. A. D. Sari et.al., 2017). The results of previous research show that Problem-Based Learning based student worksheet products facilitate the learning process, improve learning outcomes, and improve students' critical thinking skills.

This study aims to develop problem-based learning of student worksheets that are valid according to experts, practical according to teachers, and

attractive according to students. This development research is essential because there is no problem-based learning of student worksheets teaching materials on heat transfer material in class V SDN Bakalan Krajan 2 Malang. So that the development of problem-based learning of student worksheets is expected to provide considerable benefits for students to have exciting teaching materials, help make it easier to understand heat transfer material, and help students to become independent individuals in constructing a complete understanding of the material formulated in trouble.

A student worksheet is one of the learning tools that teachers often use in the learning process (A. P. P. Sari & Lepiyanto, 2016). According to Prastowo, a Student worksheet is a printed teaching material consisting of sheets of paper containing exercise activities that students must do (Prastowo, 2018). Trianto also defines a student worksheet as a guide used by students to conduct investigations or problem-solving activities by the indicators to be achieved (Trianto, 2011). The Student worksheet is a learning support tool (Fathurrohman, 2015). This is to the research of Winahyu et al., which also produced worksheets to grow students' scientific character (Winahyu et.al., 2017). Thus, Student worksheets can be interpreted as printed teaching materials and learning aids that can be used to carry out problem-solving-based activities.

Student worksheet has a function in learning. One of them can help minimize the role of educators but can encourage students to participate more actively in learning (Prastowo, 2018). In a sense, the teacher is no longer the focus of learning but only supports students in all learning activities. So that the Student worksheet allows students to practice understanding the material independently and change learning from teaching to learning. The presence of the Student worksheet has a considerable influence on the learning process, so the preparation of the student worksheet must meet several requirements. Kosasih states that the conditions that must be considered when compiling a Student worksheet

include didactic, construction, and technical requirements (Kosasih, 2021). Didactic requirements regulate the universal use of Student worksheets. That is, Student Worksheets must fulfill the principles of effective learning. Construction requirements relate to the use of language, vocabulary, sentence patterns, and clarity that students must understand. Technical requirements relate to writing, pictures, and the appearance of the Student worksheet.

Problem-based learning is a learning model categorized into a scientific approach. Rusman defines Problem-based learning as a learning model that uses real-world problems to train critical thinking and problem-solving skills in acquiring essential concepts and knowledge of the subject matter (Rusman, 2015). In line with this, Fathurrohman also defines Problem-based learning as a learning model that involves students dealing with problems in a contextual, structured way and trying to find meaningful solutions (Fathurrohman, 2015). Based on the opinions of the two experts above, Problem-based learning can be interpreted as a learning model that uses real-world problems to guide students to find meaningful solutions. Giving problems aims to train students to think critically and be skilled at solving problems from what they have learned.

Each learning model has different characteristics. Rusman stated that the Problem-based learning model has the features of presenting problems at the beginning of learning (Rusman, 2015). The problems presented are real-world or every day close issues to students' lives. In addition, the Problem-based learning model also prioritizes collaborative, communicative, and cooperative learning. That is, the Problem-based learning model encourages critical thinking skills in overcoming the complexity of problems in the real world and develops cooperation and social skills when working in teams. The Problem-based learning syntax is presented in table 1 below.

Table 1. The Syntax for Implementation of the Problem-Based Learning Model

Stage	Indicator	Teacher Behavior
1	Orientation of students to the problem	The teacher gives contextual problems through readings or activity sheets, and then these problems are solved individually or in groups by students.
2	The student organization for learning	The teacher helps students organize learning tasks related to the problems presented earlier.
3	Guiding individual as well as group investigations	The teacher encourages students to do experiments. The facts obtained from the experimental results can clarify the problem.
4	Develop and present the work	The teacher helps prepare work in the form of reports and helps students to share assignments with their friends.
5	Analysis and evaluation of the problem-solving process	The teacher helps students reflect and evaluate the processes and investigations that have been carried out.

(Fathurrohman, 2015)

Based on table 1 above, the implementation of the problem-based learning model must be carried out sequentially. By systematically carrying out the problem-based learning syntax/steps, the expected learning objectives can be achieved.

Problem-based learning student worksheets are learning materials and learning aids consisting of sheets containing guidelines for carrying out activities or activities that refer to the steps/syntax of problem-based learning. The problem-based learning syntax includes (a) orientation, (b) organization, (c) guiding investigations, (d) presenting the work, and (e) analysis and evaluation. Problem-based learning development of student worksheets is adapted to the structure and requirements for preparing

student worksheets. The arrangement of student worksheets based on problem-based learning contains the title (cover), preface, table of contents, KI, KD, indicators, learning objectives, instructions for use, supporting information, and student worksheet activities. Based on Problem-based learning, let's practice in the form of factual statements/wrongs and reflection. Problem-based learning student worksheets are divided into three actions and sections. Each section consists of "let's observe," "let's discuss," "lets a cover-up," "let's find out," and "let's convey."

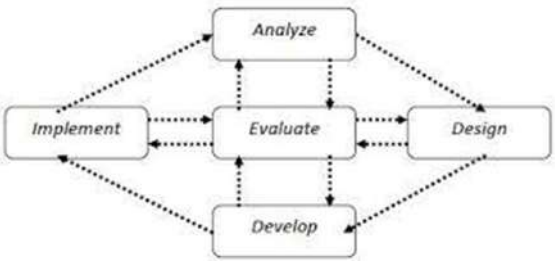
The first stage is organizing the problem, or in the student worksheet, it is called "Let's Observe!". At this stage, students face everyday issues related to heat-locking events. These problems are designed to motivate students to participate actively in problem-solving. The second stage is the learning organization or "Let's Discuss!". Students at this stage are invited to discuss learning tasks related to the problems presented in the previous step. The third stage is the investigation or "Let's Investigate!". At this stage, students conduct experiments to obtain facts and use them to solve problems. The fourth stage is the development of works or "Let's Find." At this stage, students fill in tables, answer questions related to experimental results, and draw conclusions from the experiments' results. The fifth stage is analyzing and evaluating student worksheets "Let's Convey" and "Let's Reflect." At this stage, student participants are asked to read the results of activities carried out by student worksheets and are invited to submit solutions related to the problems that have been presented. After that, the teacher discusses and evaluates the problem-solving solutions offered, and then students are asked to write reflections in the box provided. The review aims to evaluate how students have learned.

The heat transfer material is contained in the IPA class V content in the even semester of the 2013 curriculum and is adjusted to KD 3.6 and 4.6. Heat transfer material consists of conduction, convection, and radiation transfer. Heat transfer by conduction requires an intermediary substance in the

transfer process, but the intermediary substance does not move. In general, the intermediary occurs in solids, and the transfer principle is propagation. Based on their ability to conduct heat, intermediaries that conduct heat well are called conductors, and insulators are those that do not conduct heat. Heat transfer by convection involves the transfer of intermediaries and generally occurs in liquids and gases, and the principle of transfer is in the form of flow. Heat transfer by radiation is direct (radiation) and does not use an intermediary substance.

METHOD

The development of the student worksheet uses the Research and Development (RnD) method and the ADDIE development model, which consists of five stages: analysis, design, development, implementation, and evaluation. The stages used in this study are described in the following chart.



Source: (Kurnia et.al., 2019)

Figure 1. The ADDIE Model Development Stage

Based on the ADDIE development model stage chart above, the procedures carried out in product development include (1) Analysis (analyze); at this stage, the researcher conducted interviews with the class V teacher and made observations of learning in class. The analysis is conducted to discover the problems and needs during the learning process. (2) Design, at this stage, the researcher formulates learning indicators and objectives according to the specified KD, collects material and pictures, creates student worksheet storyboards, and compiles research instruments. (3) Development, at this stage, the researcher develops the student worksheet

according to the storyboard that has been made and validates the product to experts and users. (4) Implementation (implementation), this stage is the product trial stage for students. (5) Evaluation is carried out at the end of each research and development stage to minimize errors and produce valid products.

The subjects in this study consisted of 12 VA class students and 30 VB class students at SDN Bakalan Krajan 2 Malang. The type of data used is quantitative and qualitative data. Quantitative data is in the form of assessment scores, while qualitative data is in the form of suggestions for improvement. Quantitative and qualitative data were both obtained from validators, users and students. Data collection techniques used are observation, interviews, and questionnaires. Observations and interviews are used to find out problems and needs during the learning process, while questionnaires are used to determine the validity, practicality, and attractiveness of the product.

The resulting student worksheet products are assessed for validity by the validator, practicality by users and attractiveness by students. Product validity and practicality were assessed using a Likert scale questionnaire with a score of one to four referring (Sugiyono, 2016). Product attractiveness was assessed using a Guttman scale student response questionnaire. Furthermore, the validity and practicality data obtained from validators and users are converted to percentages using the formula referred to by Akbar (Akbar, 2013).

RESULT AND DISCUSSION

The Validity of Problem-Based Learning of student worksheet Heat Transfer Material According to Material Experts

The student worksheet products validated by material experts included aspects of the feasibility of the content, language, and implementation of the PBL stage. The content feasibility aspect consists of three indicators: the

material's content's suitability, the material's presentation technique, and the activities on the student worksheet. The content of the material on the student worksheet is by KD, indicators, and learning objectives. Activities on the student worksheet have also encouraged students to process problem-solving and discover material concepts independently. It's just that in the technical section, the presentation of the material has not been systematically arranged. Material experts suggest that the conductor and insulator materials in activities 4 and 5 are combined with the heat transfer material by conduction in activity 1. This is so that the facts, concepts and applications can be sequential in one activity. The opinion of Senada & All state that a systematic presentation of the material structure will help students understand their knowledge optimally (Astuti, 2017).

The second aspect is language. This aspect obtains a perfect category with a value of 88%. According to the material expert, the language presented in the student worksheet is already communicative and by linguistic rules. It's just that the material expert suggested changing the word "prove" to "investigate" in the selection of vocabulary. If you use the word "prove", students will already know if they will carry out heat transfer experiments by conduction/convection/radiation in each activity on the student worksheet. In the student worksheet that was developed, students needed to figure out what experiment they would do. Students must determine whether the experiments include heat transfer by conduction/convection/radiation, so the word used is "probe". This is by the opinion of Kosasih, which states that a good student worksheet must pay attention to construction requirements (Kosasih, 2021). One of the indicators requires using precise vocabulary to understand it.

The third aspect is the implementation of the problem based learning stage. This aspect is very valid category with a value of 95%. This consists of orientation, organization, the guidance of investigation, work presentation, analysis and evaluation. According to material experts, the presentation

section of the work needs to provide opportunities for students to write down their ideas regarding the facts obtained from experimental activities. So, researchers make product improvements by adding additional questions in the "let's find" section. It is intended that students can think more critically in explaining the facts obtained from the experimental results. Research by Untari et al. states that the primary goal of Problem-based learning is to stimulate students to have higher thinking skills (Untari et.al., 2018).

The Validity of Problem-Based Learning Student Worksheets Based on Heat Transfer Material According to Teaching Material Experts

Student worksheets validated by teaching materials experts include language, physical, and systematic aspects of student worksheets. The language aspect of the student worksheet product is in a very valid category with a value of 100%. Previously developed problem-based learning student worksheets in natural sciences to obtain a score of 82.06% (Lestari et.al., 2021). So, the language in the student worksheet is communicative and according to language rules. Communicative means that the language is simple, clear, easy to understand, and short-winded.

On the other hand, the suitability of language rules for spelling and writing is by PUEBI. This is by the opinion of Kosasih, who states that good student worksheets need to pay attention to construction requirements (Kosasih, 2021). Namely, they must pay attention to the use of language, sentence structure, vocabulary, and clarity that students can understand.

The second aspect is the physical student worksheets. This aspect consists of four indicators: the entire student worksheet, display, consistency, and picture illustrations. Overall, the student worksheets are by paper size and type and are printed in colour. The font, spacing, and layout are appropriate in the consistency section. In the display section, teaching material experts commented that the display of the contents of the student worksheet was attractive because it had a harmonious colour composition

between text, images and background. It's just that the visual appearance on the cover of the student worksheet should be rearranged so that it has aesthetic value. Based on this suggestion, the researcher made improvements to the cover of the student worksheet by redesigning the three main images in the middle of the cover to become an image with a meaning/story. This is like the opinion of Sitepu (2015), which states that the proper placement of illustrations will provide a specific aesthetic and meaning so that they can attract and motivate readers. In addition, teaching material experts also provide suggestions in the illustration section. We recommend that the image of the "detective" character on the student worksheet be changed to the "teacher" character. It is intended that the images presented are by students' lives while at school, by the technical requirements of student worksheets. According to Kosasih, a good image can support the clarity of concept and effectively convey messages to users of student worksheets (Kosasih, 2021).

The third aspect is the systematics of student worksheets. This aspect obtains a very valid category with a value of 100%. Student worksheet systematics are by product specifications. The developed student worksheet product contains a title (cover), preface, table of contents, core competencies, essential competencies, indicators, learning objectives, instructions for use, supporting information, problem-based learning based student worksheet activities, let's practice in the form of true/false statements, and reflection. This is in line with the opinion of Prastowo that student worksheet is prepared by covering titles, essential competencies, study guides, supporting information, tasks or work steps (Prastowo, 2015).

The Validity of Student Worksheets based on problem-based learning Heat Transfer Material According to Users

Product validation of student worksheets carried out by users includes aspects of content feasibility, implementation of the stages of problem-based learning, language, physical student worksheets, and student worksheet

systematics. Student worksheet products assessed by users in each aspect get a score of 100%, but the PBL implementation aspect gets a 95%. Users provide suggestions in the implementation section of the Problem-Based Learning stage to add reflection boxes to student worksheets. This is so that the teacher can find out the strengths and weaknesses of the learning that has been done. According to Khodijah, reflection is an evaluation process of how students have learned, so reflection activities aim to reduce future errors and improve learning performance in the present (Khodijah, 2013).

Users also provide suggestions regarding the appearance of student worksheets, namely adding different forms of variation in the "let's observe" section. "Let's observe, " originally in the form of a paragraph, was changed to a conversational form. This is by the opinion of Kosasih, which states that good student worksheets must pay attention to technical requirements, where one of the indicators requires that the appearance of student worksheets must be made very attractive so that students stay energized (Kosasih, 2021).

The practicality of Student Worksheets based on Problem-Based Learning on Heat Transfer Materials

The teacher carries out the practicality assessment as a user. The practicality aspect assesses the application of student worksheets that can help the learning process, ease of use by teachers and students, and student worksheet activities that involve students actively and independently. Based on the results of user assessments, the practicality aspect scored 100% in the efficient category, meaning that student worksheet products can be used without revision. Problem-based learning-based student worksheets are developing products that are practically used to support the learning process to assist the teacher's role as a facilitator. Problem-based learning-based student worksheets are also accessible for teachers and students because there are study instructions for working on student worksheets, using simple

language, and in printed form that is easy to carry. In addition, the existence of commands/questions in student worksheets can encourage students to present facts obtained from experimental activities for problem-solving. So that students can be directly involved actively and independently in working on student worksheets. Thus, student worksheets based on problem-based learning help the teacher activate students in the learning process. This is by the opinion of Prastowo, which states that student worksheets minimize the teacher's role, but activate students more in learning (Prastowo, 2015). Using problem-based learning-based student worksheets is expected to increase students' enthusiasm for learning.

The attractiveness of student worksheets based on problem-based learning Heat Transfer Material

The attractiveness of problem-based learning-based student worksheet products was obtained from student response questionnaires when carrying out a small group and field tests. The results of the product trials show that the products developed are feasible and exciting to be used in learning. Students agree if (a) the appearance and contents of student worksheets are attractive, (b) heat transfer experiments in student worksheets make them happy, (c) the language in student worksheets is clear and easy to understand, (d) illustrations/pictures are interesting, (e) learning material on the contents of student worksheets is interesting, (f) the content of material on student worksheets is easy to understand, (g) activities in student worksheets make students happy, (h) activities in student worksheets make students want to learn, (i) activities in worksheets students can make mastery of heat transfer material, (j) student worksheet activities encourage collaborative activities with group mates.

During the implementation of small group and field tests, problem-based learning student worksheets can attract students' interest and activeness in the learning process. Students are curious and enthusiastic

when carrying out experimental activities, observing, and discussing types of heat transfer with their groups. Learners who tend to be more passive can express themselves in experimental activities carried out in groups. Active students often want to find answers to questions on student worksheets. Students also report their results and conclusions at the end of each experimental activity in front of the class.

CONCLUSION

Student worksheets based on problem-based learning are very valid according to material experts by 94% and teaching material experts by 95.83%. In addition, student worksheets based on problem based learning are very practical according to teachers as users by 100% and very interesting according to students by 100% and 97.67%. So that problem-based learning student worksheets on heat transfer material in class V SDN Bakalan Krajan 2 Malang are suitable for use in the learning process without revision.

Suggestions for further research are that the material in student worksheets should be developed more broadly. So that problem based learning student worksheets do not only contain class V heat transfer material, but can develop other material such as temperature and heat material. In addition, the problem based learning model has the main characteristic of presenting real world problems at the beginning of the activity, therefore it is better if the initial activities in student worksheets can be developed and presented in the form of discussions or stories according to the problems that occur.

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