

Development Of Pisa-Oriented Problem Based Learning Media To Improve Mathematic Problem Solving Abilities Of VII Grade Junior High School Students

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Abstract – The learning media used in schools, such as worksheet, are not optimal yet to help students build their understanding. For this reason, it is necessary to develop learning media so that they can provide opportunities for students to find their own concepts and can be remembered for a long time. This study developed a PISA-oriented problem-based learning (PBL) media. This research was a development research (R&D). This research used the Plomp model which consisted of three stages, namely the preliminary research stage, the prototyping phase, and the assessment phase. At the preliminary research stage, needs analysis, curriculum analysis, concept analysis, student analysis was applied. In the prototype-making phase, a prototype development was applied which had been validated and tested. Whereas in the assessment phase, the developed prototype was tested and assessed for practicality and effectiveness, which was assessed by observation, questionnaires, and student learning outcomes. The validation of learning tools is viewed from the content validity and construct validity. The average value of the PISA-oriented PBL-based student worksheet validation was 3.57 with a very valid category. Based on the student response questionnaire, it was found that the learning media was practical with a percentage of 86.83%. Problem solving problems were given to test the effectiveness of the learning media being developed, and the results were these devices are effective for use. After all stages of development, it was concluded that the media being developed were valid, practical, and effective.

Keywords – Problem based learning (PBL), Program for International Student Assessment (PISA), Mathematical Problem Solving Ability.

I. INTRODUCTION

Mathematics is one of the subjects that plays a role in education and technological developments. This can be seen in the application of mathematics to other disciplines and its application in technological developments. Mathematics subjects need to be given to all students at the junior high school level, this is stated in the Regulation of the Minister of Education and Culture number 58 of 2014, where mathematics is one of the subjects contained in the general subjects of Group A.

One of the skills that are grown through learning mathematics found in Permendikbud number 58 of 2016 concerning Guidelines for Mathematics Subjects and Permendikbud number 21 of 2016 concerning Content Standards is that students have problem-

solving abilities. This is in line with the general objectives of learning mathematics formulated by NCTM (2000) that there are five basic mathematical abilities that students must have, namely problem solving, reasoning and proof, communication, connection, and representation. Based on the above statement, it can be seen that problem solving ability is one of the abilities that every student must have as a standard that must be developed to improve the quality of learning for the better.

Problem-solving abilities are basic skills that students must have to identify and solve problems faced in the learning process. The low ability of problem solving students was also found when giving preliminary test questions in accordance with the problem solving indicators put forward by Polya (1973), namely (1) understanding the problem, (2) planning problem solving, (3) solving problems and (4) check again. The results of the answers given by students can be seen in Figure 1 below,

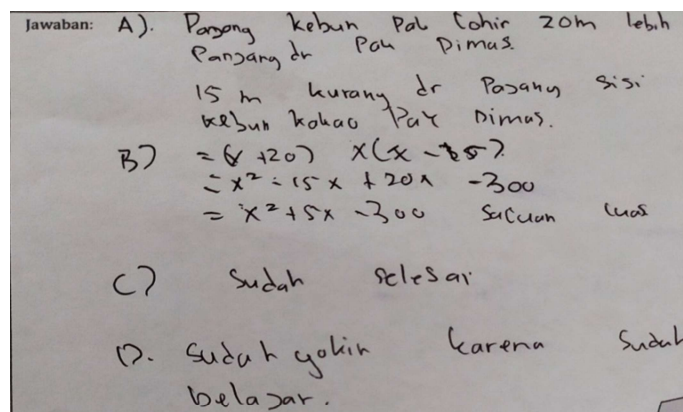


Figure 1. Examples of students' answers to the preliminary test

In Figure 1, it can be seen that students cannot describe the information contained in the questions correctly. Whereas in the completion plan students immediately write down the answers, not write down what steps will be taken to solve the problem. For indicators of solving problems and checking again, students write that they have finished and are sure because they have learned. Even though the command in the question is to solve the problem with the ideas put forward and check the answers given.

In this case, it is necessary to find a solution to improve the problem solving abilities of students so that they can be resolved properly. The success of students in learning is largely determined by the learning media designed by the teacher. The learning media serves to guide the learning process. The availability of adequate learning tools will assist teachers in carrying out the learning process so that the expected learning goals and objectives can be achieved.

Responding to the problem of students' low mathematical problem solving abilities, improvements were made in the learning process, including by using learning media that could make students more active, creative and motivated to solve problems in learning. One of the solutions that the researchers offer is by using Problem Based Learning (PBL) based learning media.

In learning using the PBL model, students are faced with a problem from the start, then followed by a student centered information search process (Suprihatiningrum, 2012; Nafiah, 2014). According to Sutirman (2013), "Problem-based learning is a learning model that departs from students' understanding of a problem, finds alternative solutions to the problem, then chooses the right solution to use in solving the problem". The stages of PBL learning according to Putra (2013) are (1) the orientation of students on problems, (2) organizing students to learn, (3) guiding individual and group investigations, (4) developing and presenting work results, and (5) analyze and evaluate the process of problem solving results. The choice of PBL model can help improve students' mathematical abilities because PBL stages are synchronized with indicators on problem solving. This is supported by the results of research conducted by Padmavathi (2013); Tarmizi, et al (2010); Firdaus, et al (2015); Tiwari, et al (2006) stated that the PBL model can improve student learning outcomes.

The advantages of the PBL model according to Warsono and Hariyanto (2013) include: 1) students will get used to face problems and feel challenged to solve it. It is not only related to classroom activities, but also in everyday life, 2) fostering social solidarity by accustomed to discuss with a group of friends then discussing with their classmates, 3) the more familiarizing the educator with the students, and 4) accustoming students to apply the experimental method.

Learning media developed to support learning activities are in the form of Student Worksheets. Worksheet aims to direct students to discover mathematical concepts themselves, because students directly carry out activities based on the steps contained in the worksheet, and assist teachers in activating students in learning activities. The questions contained in the worksheet were made with PISA question-oriented, according to OECD (2012) PISA questions were developed based on content which includes Shape and Space, Change and Relationship, Quantity and Uncertainty and data. Meanwhile, the context of the PISA questions consists of four, which are related to personal, occupational, societal and scientific contexts. And the mathematical process in PISA is classified into three groups (clusters), namely reproduction, connection, and reflection. The use of PISA questions in worksheet aims to make students accustomed to working on the PISA model questions so that they can improve the results on the next PISA test. Previous studies that developed PISA questions were Bidasari (2017), Putra, et al (2016), Hasanah (2017), Mitari (2018), Charmila (2016) and Afrilia (2019).

Based on the description above, a mathematics learning media was developed in the form of a problem-based learning based on PISA question-oriented worksheet which is expected to be able to direct and guide students to be able to improve students' mathematical problem solving abilities. So the formulation of the problem in this development is: What are the characteristics of problem-based learning tools based on PISA questions in grade VII junior high school students that are valid, practical and effective to improve students' mathematical problem solving abilities. And the purpose of this development is to produce mathematical learning media based on Problem Based Learning PISA question-oriented valid, practical and effective in improving students' problem solving abilities.

II. RESEARCH METHODOLOGY

In this research, the development model used is the Plomp model. This research is useful for developing a product in the form of a PISA-oriented PBL-based LKPD to improve the mathematical problem solving abilities of grade VII junior high school students. Learning tools developed are valid, practical and effective tools. The Plomp model consists of three stages, namely the preliminary research phase, the prototyping phase, and the assessment phase (Plomp, 2013). The preliminary research phase consists of analyzing needs, curriculum, students, and concepts. Instruments in the initial investigation phase were interview guides and student opinion questionnaires. In the prototyping phase, making this prototype a formative evaluation is carried out. The development phase or prototyping (prototyping phase) consists of prototype 1, namely self-evaluation and expert review; prototype 2 is one-on-one evaluation.

Self-evaluation is evaluating prototype 1 conducted by the researcher. This evaluation aims to double-check the components contained in the learning device that has been designed. The aspects observed in the evaluation of the learning tools developed are errors that appear such as typing errors, completeness of the components of the equipment, the suitability of the steps with the given stages, the suitability of the questions with the PISA model, the placement of images, the size of the writing and other identified errors. After the prototype is self-evaluated, it will then be evaluated by experts. Expert or expert assessment, namely asking experts or experts to provide an assessment and input on the prototype that has been designed by validating PBL-based learning media.

The assessment of experts or experts (expert review) is a process where a person or several experts conduct a review of the design of learning device products to determine their strengths and weaknesses (Tesmer, 1996). Experts assessing prototype 1 consisted of 3 mathematics education experts, 1 linguist, and 1 educational technology expert.

After prototype 1 is evaluated, revisions are made based on expert input, the revised prototype is called prototype 2. Furthermore, the prototype 2 will be evaluated one by one. The purpose of this evaluation is to identify possible errors such as poorly understood grammar, incorrect spelling, and incorrect punctuation. One-on-one evaluation will be carried out on three students of junior high school number 2 Tilatang Kamang. The instruments used were observation sheets and interview guidelines.

Worksheet is given to students and asked to work on worksheet in accordance with the existing instructions. When students work on the given worksheet, the researcher observes the implementation of the worksheet and records all events while the students are working on the worksheet. Researchers also conducted interviews with students to ask for responses to the draft worksheet.

In the assessment phase, after a one-on-one evaluation, a small group evaluation will be followed. This stage aims to assess the practicality and effectiveness of the learning tools that have been developed in implementing learning. Students who will take part in the small group are students who do not participate in one-on-one evaluations. The data from the small group trial results will be

analyzed and the learning tools will be revised again so as to produce practical and effective learning tools. The small group evaluation was carried out on 6 students of junior high school number 2 Tilatang Kamang with various levels of ability. The instruments used in this small group evaluation were student response questionnaires, teacher response questionnaires, and problem solving skills questions.

III. RESULT AND DISCUSSION

There are several analytical activities at the preliminary investigation stage (preliminary research). This aims to get all the requirements and requirements needed for the development of learning tools. The initial investigation stage consists of three activities, namely:

1. Initial Investigation Phase

PISA-oriented for PBL worksheet is designed based on the results of the analysis of the initial investigation phase. Activities in the initial investigation phase began with needs analysis, curriculum analysis, student analysis, and concept analysis. The results of the analysis of the initial investigation phase, namely the analysis of needs and context in this study, are based on the rationality of the need to develop PISA-oriented problem-based learning media, analyze competition standard, basic competency and indicators and analyze the characteristics of students.

The results of the needs analysis for the development of this tool are that students want a colored worksheet, A4 paper size, with written fonts 12. Where the problems to be discussed in the worksheet are those related to the use of mathematical knowledge in social life. worksheet is prepared based on the 2013 curriculum, with material in algebraic forms. The indicators for achieving competency are described in more detail, with the aim of optimizing the planting of concepts in students so that they can solve mathematical problems. The results of the student analysis become the basic reference for the design of learning media where information is obtained that students like learning in groups, and students like student worksheet that is attractive and colorful.

2. Development Phase or Prototyping

a. Worksheet Characteristics

Based on problem based learning has several components, namely the title listed on the cover page, greeting page, standard competency, basic competency, indicators, learning objectives, worksheet instructions, problems, work steps, and exercises. worksheet has interesting pictures according to the problems to be solved in finding the concept of the material being studied. worksheet is designed with varied and bright colors, for example blue, red and so on. This aims to generate interest from students, because in general students like bright colors. All the pictures contained in the worksheet were taken from the internet. worksheet begins by presenting questions or problems that aim to help students to relate the observed phenomena to the concept to be constructed.

Worksheet uses simple and communicative language and is in accordance with the level of communication of students, so that the presentation of the material in the worksheet can be understood well. The questions in the worksheet are arranged in clear sentences so that they are able to direct students to get the expected answers. The cover page contains the identity or title of the student worksheet based on problem based learning. The main background colors used in worksheet are blue and red. The results of designing learning devices at the initial stage are called prototype 1.

b. Self Evaluation Learning Media .

The evaluation is carried out by looking back at the results of the device design and correcting the errors found in the learning devices that have been designed. In general, many typing errors occur in typing and punctuation. Typical errors in the use of spaces and capital letters at the beginning of the sentence. Typing errors also occur in the word " mengalami " written "menglami", the word " mengerjakan " is written " pengerjakan ", the word "yang" is written "yan", the word "pascal" is written "pascar", the word " pensiun " is written as " pension ", the word " berkelompok " is written " berkelompok ", the word " bunga " is written "bunya", the word " jawaban " is written "jabawan". Furthermore, there is an error in the use of question mark punctuation which should be an exclamation mark.

c. Results of Learning Media Validation by Experts.

Worksheet that has been revised according to the evaluation results in the self-evaluation sheet will then be validated and discussed by experts. Worksheet is validated by 5 experts consisting of 3 mathematics education experts, 1 educational technology expert, and 1 Indonesian language expert. The aspects observed in the worksheet are content, language and presentation.

During the worksheet validation phase, several revisions were made based on the suggestions of the validator. The validator's suggestion is to add a reference list or bibliography, change some types of writing that are less legible. Based on the suggestions of the validator, a revision was made to the Worksheet so that a valid worksheet was obtained.

The score of each indicator in the worksheet ranges from 3.4 to 3.7 with the very valid category. The results of the worksheet validation as a whole can be seen in Table 1.

Table 1. Overall worksheet Validation Results

No	Validation aspects	Validation score	Category
1	Content and presentation	3,42	Very valid
2	Graphic and display	3,55	Very valid
3	Language feature	3,75	Very valid
Average		3,57	Very valid

Based on Table 1, it can be concluded that the PISA-oriented for PBL-based worksheet designed is valid, which is seen from all aspects. After the revision of prototype 1 was made, the results of the revision were called prototype 2.

d. One-on-one Evaluation Results

The activities carried out in prototype 2 were one-to-one evaluation. The worksheet was tested on 3 grade VII students of junior high school Tilatang Kamang. Students are asked to pay attention to the clarity of the worksheet usage instructions, typing errors found in the worksheet, and to work on the questions contained in the worksheet. The trial was carried out at a different time for each student. One-on-one evaluation was conducted 5 times.

At the first meeting, namely using worksheet 1, students were confused with each question and stage contained in the worksheet, the researcher gave a little direction to the students. However, at the next meeting students began to understand the stages and steps of the worksheet. There were several improvements to the worksheet including typing errors, illegible type of writing, and some words in the questions that were deleted or replaced because students did not understand the meaning of the question.

After learning by using PISA-oriented for PBL-based worksheet, interviews were conducted with students. From the results of the interview, the three students were interested in using the worksheet that had been used. But to solve the problem. Highly skilled students can solve only by reading the questions once, but there are also some questions that must be read three times. Meanwhile, students with medium and low abilities must read the questions two to three times.

After the worksheet revision process was complete, improvements were made to prototype 2 according to the suggestions of students. The revision result on prototype 2 is called prototype 3. Next, practicality test was conducted on the PBL-oriented PISA-based student worksheet. The practicality test aims to determine the extent of the benefits, ease of use and time efficiency of using PISA-oriented for PBL-based worksheet by teachers and students.

3. The Assessment Phase

Furthermore, prototype 3 was tried out at the small group stage (small group test) on 6 class VII students of junior high school number 2 Tilatang Kamang. In learning students are divided into two groups. The research was conducted in 5 meetings. At this stage, the practicality of the learning device is seen, which is seen from the results of the student response questionnaire analysis. Student response questionnaire data can be seen in Table 2 below.

Table 2. Student Response Questionnaire Results to worksheet in Small Group Evaluation

Scoring Aspects	Practicality percentage (%)	Category
Easiness	93,5	Very practical
Attractiveness	92	Very practical
Time allocation	85,5	Very practical
Understandable degree	83,14	practical
Advantage	79	practical
Average	86,83	Very practical

Based on table 2, it can be seen that the PISA-oriented for PBL-based worksheet for each aspect of the assessment is in the very practical category, and the percentage of practicality of PBL-based learning media is 86.83%.

Furthermore, the worksheet effectiveness test was carried out which was seen from the results of the students' problem solving abilities by answering the questions given after using PISA-oriented PBL-based worksheet. The following is an example of students' final test answers on the final test with PISA question content changes and relationships, work context, connection process competence and questions with level 3.

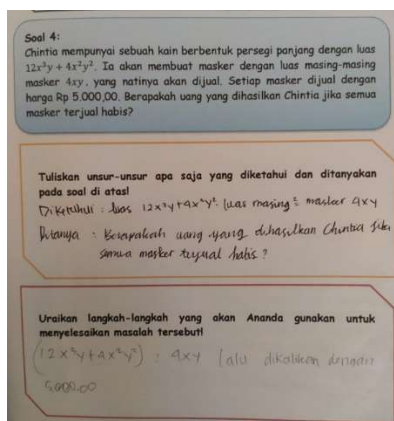


Figure 2. Examples of students' answers on the final test

From Figure 2 above, it can be seen that students are able to write down information, even though it is not perfect. In solving the questions, students have been able to write down the steps for solving the questions and solve the questions with the steps that have been described.

From the results of the final test, it was found that 4 students completed and 2 students did not complete. Where the average obtained is 69.72, so it can be said that the learning tools that have been developed are effective. The test results of students' problem solving abilities on the small group evaluation can be seen in table 3 below

Table 3. Results of the Mathematical Problem Solving Ability Test in a Small Group Evaluation

participant	KKM	Test result	Explanation
1	70	90	passed
2		76,67	passed
3		48,33	Not passed
4		81,67	passed
5		78,33	passed
6		43,33	Not passed
Average		69,72	

IV. CONCLUSION AND SUGGESTION

Based on the results of the data analysis that has been done, it can be concluded that the PISA-oriented problem-based learning media developed are valid, practical, and effective to be used to improve the problem-solving abilities of class VII students of SMPN 2 Tilatang Kamang. Based on the above conclusions, PISA-oriented for problem-based learning media can be used as a guide for teachers in implementing learning.

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