



The Design of Student Worksheet Problem based Learning to Improve Problem Solving Ability of the Eighth-Grade Students Junior High School in Indonesia

Tio Akma^{1*}, Suparman²

^{1,2}Master of Mathematics Education, University of Ahmad Dahlan, Indonesia

*Corresponding author E-mail: tioakmalionel@yahoo.com

Abstract

The purpose of this research is to develop the design of the student worksheet Problem-Based Learning to improve the problem-solving ability of eighth-grade junior high school students. This research uses Four-D development model. The development procedure includes four stages: define, design, develop, and dissemination. The subjects of the study were eighth graders of junior high school 9 Yogyakarta, Indonesia. The object of this research is curriculum, student characteristics and evaluation of teaching materials. This research resulted in a) the results of needs analysis of student worksheet Problem Based Learning to improve problem-solving abilities appropriate to the curriculum, student characteristics, learning materials and objectives. b) the results of the Student Worksheet design consisting of the cover, introduction, table of contents, instructions manual, basic competence, supporting information, action steps, and exercise. This research can be continued to develop and dissemination.

Keywords: *Problem based learning; problem solving; worksheet.*

1. Introduction

Mathematical problem solving is a search for solutions to mathematical problems encountered by using all the mathematics knowledge possessed by learners [1] and someone with problem-solving skills is a confident, creative, and independent thinker [2] so that problem-solving skills are one of the must-have capabilities students in the 21st century [3]. Currently, the focus of mathematics education is to ensure students can apply the knowledge and skills they learn to everyday life, and students are expected to develop their problem-solving skills to cope with obstacles by adopting multiple points of view [4]. Problem-solving skills are central to the mathematics curriculum [5], and NCTM puts problem-solving skills as one of the primary goals of mathematics education [6]. Problem-solving is part of an essential mathematical curriculum because, in the learning and completion process, students use the knowledge and skills they need to apply to solve problems [7]. Ulya, Kartono, & Retnoningsih stated that mathematics could not separate from problem-solving [8].

Student problem-solving abilities in Indonesia in international study, the Program for International Student Assessment (PISA) in 2015 showed not good results and was below the global average [9]. The level of problem-solving ability of Indonesian students is still weak in solving a non-routine problem or high level [10]. One of the factors that cause the students to have difficulty in solving the problem that is students have not been able to master the concept and have not been able to find the right strategy in solving math problems [11]. Rohmah & Sutiarmo stated that the student's error factor is not absorbing information well, not understanding problem transformation, not following the material thoroughly and understanding mathematically from a weak concept [12]. Mathe-

matical problem-solving tests should often be tested to students so that students become accustomed to solving problems of mathematical problem solving and students are always reminded to resolve existing issues according to troubleshooting indicators consisting of understanding, planning, completing and re-examining [13].

Efforts to improve all that can do with the selection of appropriate and innovative learning models. One of the proper learning models for learning is Problem Based Learning. Problem Based Learning is a centered instructional approach that empowers learners to conduct research, integrate theory and practice, apply knowledge and skills to develop appropriate solutions to defined problems [14], instructional strategies that claim to support high-level learning as students attempt to solve unstructured problems [15]. Problem Based Learning is student-centered learning [16] and can create a more innovative and effective education because students are more geared toward thinking skills and play a more active role during the learning process, seen when students face problems related to daily life and more effort looking for solutions when learning or discussing [17]. Problem Based Learning has problem centered characteristics that are needed to support learning in solving problems [18], and problem-based learning can improve learning activities, students' math problem-solving skills [19], the student's answer process taught through problem-based learning better understanding, planning, problem-solving, and examine the answers [20], and there are significant effects on students' self-learning abilities [21]. Wilder says problem-based learning not only fosters the development of content knowledge, but also various skills, such as communication and collaboration skills, problem-solving, decision-making, critical thinking, and self-study [22].

To implement problem-based learning more effectively requires learning resources that can support learning such as Student Worksheet. Student Worksheet is a guide that students use to conduct learning activities [23]. Student Worksheet contains a set of necessary actions that must be done by students to maximize understanding in the effort of forming essential skills following indicators of achievement of learning outcomes. Student Worksheets are part of teaching aids intended to facilitate teaching and learning activities and make it easier to understand the concepts of learning. The purpose of this research is to develop the design of Student Worksheet Problem Based Learning to improve the problem-solving ability of eighth-grade junior high school students.

2. Method

This type of research is development research. The product developed in the study is a student worksheet Problem-Based Learning to improve students problem-solving abilities. The research model uses Four-D development model. Development of this article refers to four stages: define, design, develop, and dissemination [24]. The subjects of the study were the eighth-grade students' junior high school 9 Yogyakarta, Indonesia. The object of this research is curriculum, student characteristics and evaluation of teaching materials. Data collection instruments include questionnaires, observation guides, interview guides, and questions. Observation guidelines are conducted to extract curriculum data and student characteristics. Interview guidelines are used to retrieve teaching resource evaluation data. The questions are used to look at students' abilities. Data analysis uses Miles and Huberman consisting of data reduction, display, and conclusions. The development flow can see in Figure 1. This research is carried out until the design stage.

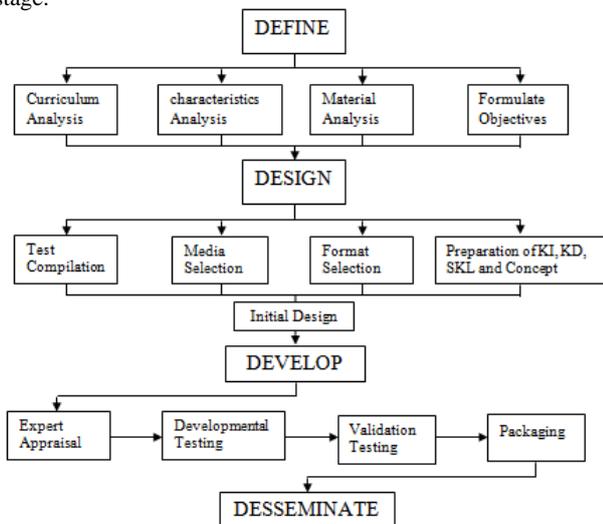


Fig. 1: Development flow

3. Result and Discussion

3.1. Define Stage

The entire document should be in Times New Roman. The font sizes to be used are specified in Table 1. Development of Student Worksheets using Four-D development model begins with the define stage. Previously this problem analysis phase was so done that the required student worksheet based PBL to improve the problem-solving ability to the eighth grade even semester of junior high school. Based on discussions with teachers of mathematics in junior high school 9 Yogyakarta obtained information that teachers have not developed teaching materials such as student worksheet. The results of the researcher's discussion with the teacher indicate that the student worksheet used by teachers and students

is the student worksheet purchased from the publisher. Based on the results of conversations with teachers, there are some weaknesses of the Student Worksheet of the publisher among them is not cover all the indicators of achievement of competence composed by the teacher, the order of presentation is not based on the request from easy to challenging, and does not lead to students more active in learning. The tests or competency tests performed so far do not contain problem-solving steps. Furthermore, in the definition phase it is shown starting with (a) curriculum analysis, (b) analysis of receiver characteristics, (c) material analysis, and (d) formulating objectives [25]. The curriculum used is the curriculum 2013, a study of the components of students that include competence, attitudes toward learning tools, media, format and language that students want on learning devices. The level of competency of eighth graders A and eighth grade B junior high school 9 Yogyakarta as a test subject belongs to the medium category. It can see from the average value of daily math tests for both classes 75 and 76. Student competence in mathematics subjects is quite heterogeneous divided into categories high, low and medium. Based on discussions with teachers and students obtained information that students love learning by using the student worksheet. Students, however, expect the student worksheet that can lead them to work on math problems actively. Also in the student worksheet of the publisher, many routine questions that have frequently been found and required in this student worksheet is a non-routine problem to train students' math problem-solving skills. Students need the student worksheet with the difficulty level format from low to complicated and the language in student worksheet that is clear and easy to understand by students and student worksheets with an exciting appearance. In the defining stages, a compilation of competency achievement indicators, a material analysis will be taught, and the preparation of the objectives of junior high school mathematics learning in eighth grade.

3.2. Design Stage

The next stage is the design stage. This stage does by designing the product of the student worksheet according to the analysis result in the define stage. The student worksheet composed contains the component (a) of the cover, (b) the introduction, (c) the table of contents, (d) the instruction manual, (e) basic competence (f) the supporting information, (g) the action steps, and (h) the exercises. Activity steps based on Problem Based Learning. In the student worksheet, there are activities that students do in groups and provide opportunities for students to find their concepts to be learned. The result of the initial design is called draft 1.

(a) Cover

Cover Worksheet Mathematics students are entitled "LKS Problem Based Learning." LKS is designed based on Problem Based Learning learning for Opportunity material and used for the eighth grade. The cover can see in figure 2.

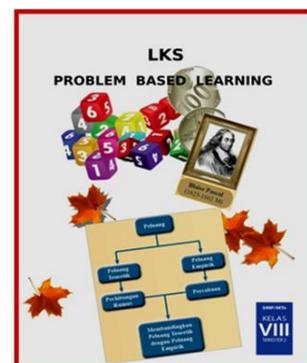


Fig. 2: Cover

(b) Introduction

The introduction serves to deliver the reader to the content or descriptions contained in the LKS. The presentation not only in-

cludes a thank-you to God and the people who helped write and apologize, but the opening also consists of an overview of the subject and comes with a description that encourages others to read LKS. The introduction can see in Figure 3.



Fig. 3: Introduction

(c) Table of Contents

Table of contents serves to make it easier to find the material you want to learn. The table of contents is organized in order of order on the pages in the LKS. Table of contents can see in figure 4.

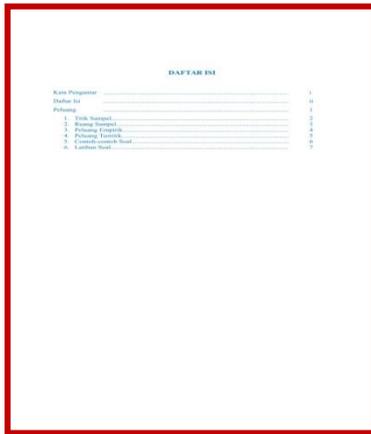


Fig. 4: Table of Contents

(d) Instruction Manual

A clue is a way of explaining something to show the direction of how something should do. This instruction manual describes how students use LKS. The instruction manual can see in figure 5.



Fig. 5: Instruction Manual

(e) Basic Competence

Basic competence is the result of curriculum analysis that contains achievement of learning outcomes that must be achieved by students. It can see in figure 6.

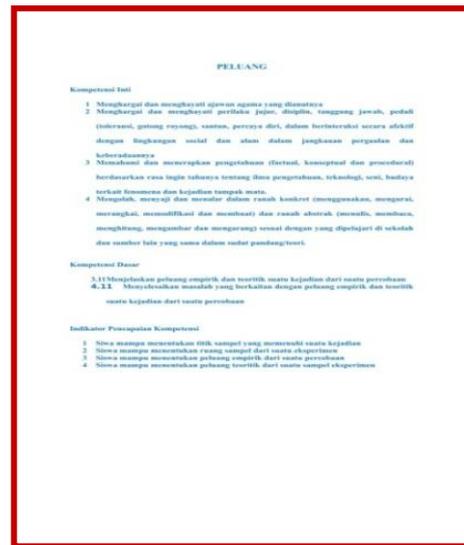


Fig. 6: Basic Competence

(f) Supporting Information

Figure 7 is a sample of the Supporting Information, is additional information that can complement the teaching materials so that students more easily to master the knowledge to be gained. The supporting information contains articles on the best-prepared opportunities to make it easier for students to understand the material.

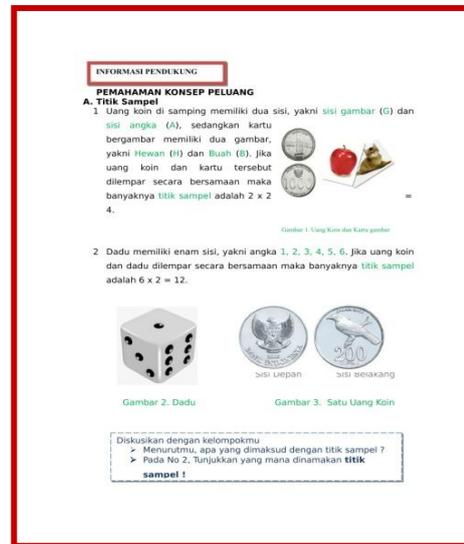


Fig. 7: Supporting Information

(g) Action Steps

Actions steps contain some procedural steps that students must do in learning the material and the problems presented. In the operation of the activity consists of the issues presented for the work of students in groups, the steps of processes based on the stages of learning Problem Based Learning. Actions steps can see in figure 8.

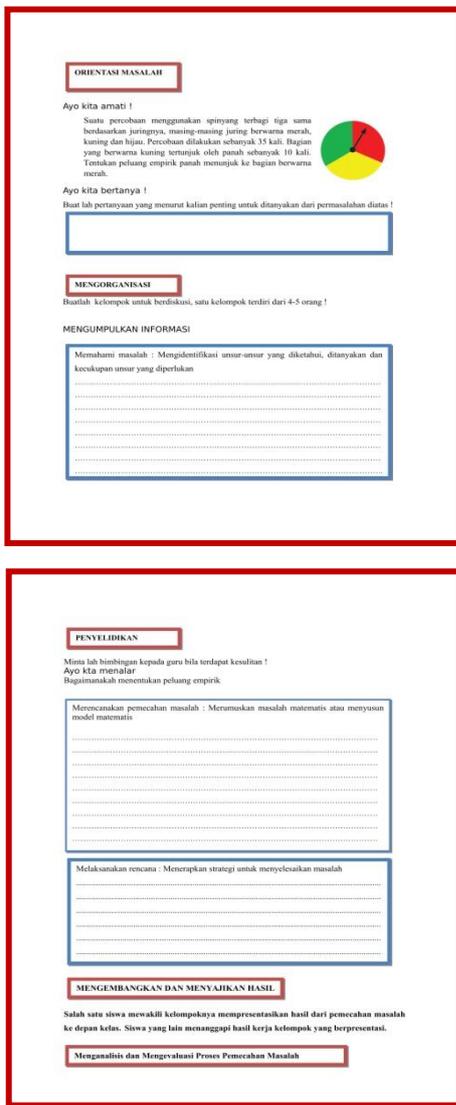


Fig. 8: Actions Steps

(h) Exercise

An exercise is a form of an assignment given to the students to practice skills after learning the teaching materials. Questions used to determine the level of mastery of students material and to measure students' problem-solving skills after following the learning process and in the workout of the exercise has immediate steps problem-solving. It can see in figure 9.

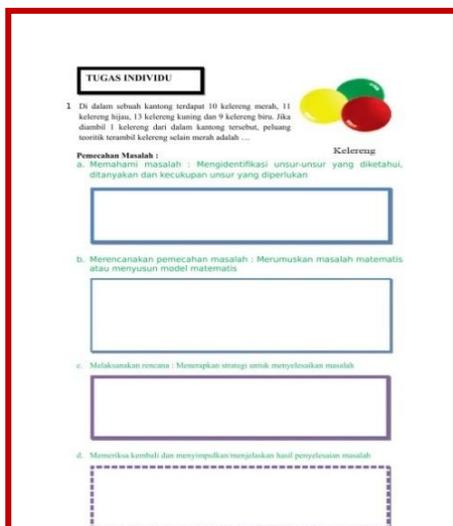


Fig. 9: Exercise

4. Conclusion

This research resulted in the design of student worksheet Problem-Based Learning to help improve students problem-solving ability. Student worksheet design has the potential to improve student problem-solving skills. The defining result is that students prefer learning by using students worksheets, but students expect students' worksheets that can lead them to work on mathematical problems actively. Also in the student worksheet of the publisher, a lot of routine questions that have been found and required in the student worksheet is a non-routine problem to train students' math problem-solving skills. Students want the worksheet with the difficulty level format from low to hard, explicit language and easy to understand by students and have an attractive appearance.

The results of the design obtained components of the student worksheet consisting of (1) a cover, (2) introduction, (3) table of contents, (4) instruction manual, (5) basic competence (6) supporting information, (7) action steps, and (8) exercises. The next research steps will proceed to the stage of development and dissemination

5. Suggestion

The design worksheet student Problem-Based Learning is designed to improve the problem-solving abilities of eighth-grade high school students. This research can be developed in the development stage and to the field testing phase to determine the practicality and effectiveness of the student worksheet

References

- [1] Widodo SA & Turmudi (2017), Guardian Student Thinking Process in Resolving Issues Divergence. *J. Educ. Learn.* vol. 11, no. 4, pp. 432–438.
- [2] Özreçberoglu N & Çağanağa CK (2018), Making It Count: Strategies for Improving Problem-Solving Skills in Mathematics for Students and Teachers' Classroom Management. *EURASIA J. Math. Sci. Technol. Educ.* vol. 14, no. 4, pp. 1253–1261.
- [3] www.p21.org (2016), Framework for 21st Century Learning. P21 PARTNERSHIP FOR 21ST CENTURY LEARNING.
- [4] Tai W & Lin S (2015), Relationship between problem-solving style and mathematical literacy. *Educ. Res. Rev.* vol. 10, no. 11, pp. 1480–1486.
- [5] Karatas I & Baki A, The effect of learning environments based on problem solving on students' achievements of problem solving. *Int. Electron. J. Elem. Educ.* vol. 5, no. 3, pp. 249–267, 2013.
- [6] NCTM (2000), Principles and Standards for School Mathematics. Unites States of America: The National Council of Teachers of Mathematics, Inc.
- [7] Misu L (2014), Mathematical Problem Solving of Student by Approach Behavior Learning Theory. *Int. J. Educ. Res.*, vol. 2, no. 10, pp. 181–188.
- [8] Ulya H, Kartono & Retnoningsih A (2014), Analysis of Mathematics Problem Solving Ability of Junior High School Students Viewed from Students' Cognitive Style. *Int. J. Educ. Res.*, vol. 2, no. 10, pp. 577–582.
- [9] OECD (2016), Programme for International Student Assessment (PISA) Results from PISA 2015, www.oecd.edu/pisa, pp. 1–8.
- [10] Novita R, Zulkard & Hartono Y (2012), Exploring Primary Student's Problem-Solving Ability by Doing Tasks Like PISA's Question Rita. *IndoMS. J.M.E.* vol. 3, no. 2, pp. 133–150.
- [11] Tio Akma (2017), Mathematical Problem Solving Skills in Two Variable System of Linear Equations. *International Conference on Education and Science.*
- [12] Rohmah M & Sutiarto S (2018), Analysis Problem Solving in Mathematical Using Theory Newman. *EURASIA J. Math. Sci. Technol. Educ.*, vol. 14, no. 2, pp. 671–681.
- [13] Telaumbanua YN, Sinaga B, Mukhtar & Surya E (2017), Development of Mathematics Module Based on Metacognitive Strategy in Improving Students' Mathematical Problem Solving Ability at High School. *J. Educ. Pract.*, vol. 8, no. 19, pp. 73–80.

- [14] Savery JR (2006), Overview of Problem-based Learning: Definitions and Distinctions Origins of PBL. *Interdiscip. J. Probl. Learn.*, vol. 1, no. 1, pp. 9–20.
- [15] Tawfik A & Trueman R (2015), Effects of Case Libraries in Supporting a Problem-Based Learning STEM Course. *J. Educ. Technol. Syst.*, vol. 44, no. 1, pp. 5–21.
- [16] Bergstrom CM, Pugh KJ, Phillips MM & Machlev M (2016), Effects of Problem-Based Learning on Recognition Learning and Transfer Accounting for GPA and Goal Orientation. *J. Exp. Educ.*, vol. 84, no. 4, pp. 764–786.
- [17] Harahap MB (2017), The Effect of Problem-Based Learning Assisted Concept Map to Problem-Solving Ability and Critical Thinking Ability. *J. Educ. Pract.*, vol. 8, no. 19, pp. 60–65.
- [18] Jonassen D (2011), Supporting Problem Solving in PBL. *Interdiscip. J. Probl. Learn. Vol.*, vol. 5, no. 2, pp. 9–27.
- [19] Simamora RE, Sidabutar DR and Surya E (2017), Improving Learning Activity and Students' Problem Solving Skill through Problem Based Learning (PBL) in Junior High School. *Int. J. Sci. Basic Appl. Res.*, vol. 33, no. 2, pp. 321–331.
- [20] Saragih S & Habeahan WL (2014), The Improving of Problem Solving Ability and Students' Creativity Mathematical by Using Problem Based Learning in SMP Negeri 2 Siantar. *J. Educ. Pract.*, vol. 5, no. 35, pp. 123–133.
- [21] Surya E, Syahpurta E & Juniati N (2018), Effect of Problem Based Learning Toward Mathematical Communication Ability and Self-Regulated Learning. *J. Educ. Pract.*, vol. 9, no. 6, pp. 14–23.
- [22] Wilder S (2015), Impact of problem-based learning on academic achievement in high school: a systematic review. *Educ. Rev.*, vol. 67, no. 4, pp. 414–435.
- [23] İnan C & Erkuş S (2017), The Effect of Mathematical Worksheets Based on Multiple Intelligences Theory on the Academic Achievement of the Students in the 4th Grade Primary School. *Univers. J. Educ. Res.*, vol. 5, no. 8, pp. 1372–1377.
- [24] Sivasailan T, Semmel DS & Semmel MI (1974), *Instructional Development for Training Teachers of Exceptional Children: A Sourcebook*.
- [25] Pardimin & Widodo SA (2017), Development Comic Based Problem Solving in Geometry. *Int Electron J Math Educ* 12 (3) pp 233–241.