Improving Students' Problem-Solving Ability through Learning Tools Based on Problem Based Learning

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Abstract. Our preliminary research conducted on students grade VII of junior high school showed that the students' mathematical problem-solving ability was still low. We suspected that learning tools used so far have not been able to facilitate students to develop mathematical problem-solving abilities. The low ability to solve mathematical problems of students can be overcome by developing learning tools based on Problem Based Learning. The purpose of this study was to analyse the results of the development of learning tools based on Problem Based Learning to improve the mathematical problem-solving ability of students in grade VII. This type of research is development research where the subjects were students grade VII of junior high school. We used the Plomp model which consists of three stages; investigation, development or prototype, and the assessment. The instruments used to find out the practicality of the learning tools developed were interview guidelines, student questionnaire responses, teacher questionnaire responses, and observation sheets for the implementation of lesson plans. The results showed that our newly developed learning tools have been practical for use in the learning process.

1. Introduction
The ability to solve mathematical problems is one of the abilities that is very important in the process of learning mathematics. Problem solving skills are part of the mathematics curriculum that gives students the opportunity to gain new knowledge by using the knowledge and skills they already have to apply to problem solving that is not routine. Given the importance of problem-solving skills in the learning process, the problem-solving abilities of students need to be improved from the level of basic education. However, to improve students' problem-solving abilities is not easy, many obstacles are encountered in the learning process. In fact, the ability to solve mathematical problems of students is still low. This is evident from several previous studies conducted by [6], [7], [9], [12], [13] and studies at the international level by [3], [5], [8], [11], [14], [15], [17]. The results of these studies indicate that students' mathematical problem-solving abilities are low.

This was also found in the field when researchers conducted preliminary research on September 8-15, 2018 at 26 State Junior High School in Padang. The teacher gives questions that can see students' problem solving abilities as follows:
Adit and Daffa raise ducks. Adit have 6 cages with 20 cages in each of cage. Daffa have 7 cages where each cage contained 5 times more than those of Adits’s. Please determine how many ducks they both have?

When students work on the problem, there are some indicators of problem-solving ability that are not visible. Students have difficulty in understanding the problems that are given so that students cannot obtain the elements that are known and asked for the problem. Most of the students rewrote the problem. Learners also have difficulty determining the steps of problem solving so that the problems given cannot be solved properly, the low mathematical problem-solving ability of these students is also shown from the results of tests of students' mathematical problem-solving abilities in preliminary research which can be seen in table 1 below:

Table 1. The percentage of the test result of mathematical problem-solving ability of the student’s semester 1, grade VII, in two junior high schools, year 2018/2019

| School               | Number of student | Percentage of completeness (%) |
|----------------------|-------------------|--------------------------------|
| SMP Negeri 26 Padang | 32                | 40.63                          |
| SMP Negeri 34 Padang | 31                | 41.67                          |

Table 1 showed that the test results of students' mathematical problem-solving abilities in preliminary studies that were above the average had not reached 50%. It can be concluded that the students' mathematical problem-solving ability is still low.

Researchers also observed the lack of active students in the learning process. Students who respond in the learning process was the same over time in the learning. When the teacher gives examples of questions that are in a different shape to the questions in the previous example, students look confused to solve them. This was because students have not been able to understand the subject matter properly. Based on observations and interviews with teachers obtained information that students find it difficult to solve problem solving problems. Students are used to solving routine problems which the problems are similar to the example that has been given. The student worksheet also did not facilitate students to develop mathematical problem-solving skills. There are no steps that guide students to solve problems systematically so that they can be resolved properly. The language in the source book was also difficult to understand thus students prefer to listen from their teacher than reading the book.

All those problems mentioned above caused the learning objectives were still not achieved. The major factor was the lack of optimal preparation of learning tools (student worksheet and lesson plan) [1,4]. To solve those problems is to develop a learning tool based on Problem Based Learning (PBL) where it begins by giving a problem related to the daily life.

Problem-based learning is defined as a learning that has the characteristics of using real problems as a context for students to be skilled in solving problems, understanding material, and critical thinking. PBL is applied so that the students obtain essential knowledge and concepts from the material being studied [7]. In addition, PBL can help students understand the material well, challenge the ability of students to discover new knowledge, make students active in the learning process, and provide opportunities for students to apply their knowledge in everyday life.

The model can improve students’ problem-solving abilities as it has succeeded in in many studies [2], [5], [13], [15], and [16].

Learning tools developed in this study are student worksheet and lesson plan. The learning tools developed contains PBL steps. PBL steps in this study are the orientation of students on the problem, organizing students to learn, guiding the investigation of students both individually and in groups, developing and presenting the work and analyzing and evaluating the problem-solving process.
2. Methods
This type of research is development research. Development research is a research method that produces a product and tests its validity, practicality, and effectiveness. The development model used is the Plomp model which consists of three stages, namely the initial investigation stage, the development and prototype stage, and the assessment stage.

At the initial investigation stage there is a needs analysis, student analysis, curriculum analysis, and concept analysis which is useful for knowing the guidelines in designing learning tools to be developed. The prototype development and manufacturing phase is the process of developing and manufacturing learning tools in stages to improve and improve the prototype that was developed. While the assessment stage is useful to conclude whether the product produced is in accordance with what is desired.

The subjects in this study were students of grade VII junior high school, SMP Negeri 26 Padang. To determine the practicality of the product, data collection was carried out using instruments at one-on-one, small groups, large groups or field tests. To find out the practicality of the learning tools developed, the one-to-one stage is to use instruments in the form of students' interview guidelines, the small group stage using student response questionnaires, and in large groups using student response questionnaires, teacher response questionnaires, and the RPP implementation sheet.

3. Result and Discussion
Data on the practicality of learning tools were obtained from one-on-one evaluations, small groups and large groups. This practicality test aims to see the ease of use of learning tools that have been developed.

3.1. One to one Evaluation
In one to one evaluation data on the practicality of learning tools were obtained from interviews with students. Interviews were conducted with three students and we obtained the information that:

1) The developed worksheet is interesting to use.
   The design and colors on the cover and appearance of the student worksheet successfully attract the interest of students to use it. The cover on worksheet contains pictures relating to the material being studied and the characteristics of the learning model that will be used.
2) The language used in student worksheet is easy for students to understand.
   The percentage of students who said that the language of student worksheet was easy to understand was 66.7%.
3) The size of the letters and writing on the student worksheet is clear and legible.
4) Some student worksheets still have some typing errors.
5) The pictures displayed on student worksheet can help students in understanding the problems presented.
6) Learning using the developed student worksheet makes it easy for students to understand the material
7) Most students say that students can use student worksheets according to the time allotted.

3.2. Small Group Evaluation
In the small group evaluation data on the practicality of learning tools were obtained by questionnaire responses of students. The results of the questionnaire analysis of students' responses at the small group evaluation stage can be presented in figure 1.
Figure 1. The percentage of the practicality of student worksheet based on the results of questionnaire analysis of student responses at the small group evaluation stage. 1, aspect of presentation; 2, aspect of the ease of use; 3, aspect of time allocation; 4, aspect of legibility.

Figure 1 showed that the practicality of all aspects assessed is in the practical and very practical categories. The highest practicality percentage of student worksheet from all aspects is the readability aspect. Students can understand the instructions for using the student worksheet, the type of writing and size are clear and can be read by students clearly. Students can also carry out activities in student worksheet in accordance with the specified time. It can be said that the developed student worksheet has been practically used by students in the learning process.

3.3. Field Test
In the field test the practicality of the learning device data is obtained by the student response questionnaire, teacher response questionnaire, and observation sheet of the implementation of lesson plans. The results of the analysis of the questionnaire responses of students at the field test stage can be presented in figure 2.

Figure 2. Percentage of practicality of student worksheet based on students' questionnaire analysis results at the field test stage. 1, aspect of presentation; 2, aspect of the ease of use; 3, aspect of time allocation; 4, aspect of legibility.

From the analysis of the questionnaire responses of students towards student worksheet developed at the small group evaluation stage is the percentage of practicality student worksheet is in the practical category and very practical from all aspects assessed. Students can understand student
worksheet instructions well. The pictures contained in student worksheet help students in understanding the problems presented. The time given is sufficient for students to carry out activities contained in student worksheet. The highest percentage of practicality of student worksheet is in the aspect of legibility. It can be said that student worksheet has been practically used by students. The results of the teacher response questionnaire analysis can be presented in Figure 3.

![Figure 3. Percentage of practicality of learning tools based on the analysis results of teacher response questionnaire in the field test stage. 1, aspect of presentation; 2, aspect of the ease of use; 3, aspect of time allocation; 4, aspect of legibility.](image)

From the results of the questionnaire analysis the teacher's response to the learning tools developed at the field test stage was the percentage of practicality of student worksheet in the practical category and very practical from all aspects assessed. student worksheet can help teachers in the learning process and help students in understanding the material. The use of student worksheet can also assist teachers in utilizing the time allocation available at each meeting. Overall aspects of practicality obtained from the teacher response questionnaire was 86.46% in the very practical category. Based on the results of the observation analysis of the implementation of the lesson plan, the practicality percentage of preliminary aspects is 93.46% in the very practical category. The practicality aspect of the core activities is 88.78% and the closing activity aspect is 90.11% in the very practical category.

3.4. Conclusion
Student worksheet that has been developed was practically used by students. The results of the questionnaire analysis of students' responses at the evaluation stage of the small group as a whole were in the practical category. The results of the questionnaire responses of students as a whole was 83.76% in the practical category and the analysis of the questionnaire responses of the teacher as a whole was 86.46% in the very practical category. While the results of the analysis of the observation sheet of the implementation of the overall lesson plan were 90.11% in the very practical category. From the description above it can be concluded that PBL-based learning tools developed have been practical for use in the learning process.

References
[1] Barlenti I 2017 Pengembangan LKS berbasis project based learning untuk meningkatkan kemampuan pemahaman konsep Jurnal unsyiah
[2] Fatimah F 2012 Kemampuan komunikasi matematis dan pemecahan masalah melalui problem based learning Jurnal pendidikan dan evaluasi pendidikan UT padang
[3] Fitriani N 2017 Hubungan antara kemampuan pemecahan masalah matematis dengan self confidence siswa SMP yang menggunakan pendekatan pendidikan matematika realistik Jurnal euclid 2 341
[4] Iqbal M 2017 Pengembangan lembar kerja peserta didik (LKPD) dengan pendekatan kotekstual ditinjau dari pemahaman konsep dan disposisi matematis Jurnal unila
[5] Kodrayati L and A Budi 2016 Pengaruh model PBL terhadap kemampuan komunikasi dan kemampuan pemecahan masalah matematika kelas V SD PE
[6] Mawaddah S and H Anisah 2015 Kemampuan pemecahan masalah matematis siswa pada pembelajaran matematika dengan menggunakan model pembelajaran generatif (generative learning) di SMP JPM 2
[7] Sumartini T S 2016 Peningkatan kemampuan pemecahan masalah matematis siswa melalui pembelajaran berbasis masalah Jurnal Mosharafa 2
[8] Thuy P V 2017 Developing students metacognitive skills in mathematics classroom. Vietnam Anale Seria Informatică 1
[9] Ulvah S Kemampuan pemecahan masalah matematis siswa ditinjau melalui model pembelajaran SAVI dan konvensional JRPM
[10] Dhoriva U W and U R Widianti 2017 Analisis kemampuan pemecahan masalah matematika dan self – efficacy siswa SMP negeri di kabupaten ciamis JRPM 2 166-175
[11] Wadelin D 2014 Teaching mathematical modelling and problem solving a cognitive appreicenship approach to mathematics and engineering education Sweden JEP 4
[12] Windari F 2014 Meningkatkan kemampuan pemecahan masalah matematika siswa kelas VIII SMPN 8 padang tahun pelajaran 2013/2014 dengan penggunaan pembelajaran inkuiri JPM 2
[13] Subhan M, A A Putra and Y Yerizon 2013 Student responses toward student worksheets based on discovery learning for students with intrapersonal intelligence IOP Conf Series 335 1-4
[14] Yerizon Y and H N Dewi 2019 Development of student worksheets based on discovery learning to improve sudent mathematical problem solving ability in class X senior high school LIJSRT 8
[15] Yuliasari E 2017 Ekperimentasi model PBL dan model GDL terhadap kemampuan pemecahan masalah matematis ditinjau dari kemandirian belajar JIMP
[16] Yustianingsih R 2017 Pengembangan perangkat pembelajaran berbasis problem based learning (PBL) untuk meningkatkan kemampuan pemecahan masalah matematis peserta didik kelas VIII JNPM
[17] Zulfah 2017 Pengaruh penerapan model pembelajaran kooperatif tipe think pair share dengan pendekatan heuristik terhadap kemampuan pemecahan masalah matematis siswa MTs negeri naumbai kecamatan kampar JC 2 1 – 12