The development of mathematics’ worksheets based on problem solving at the numbers topics

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Abstract: This study aims to determine (1) validity of mathematics’ worksheets based on problem-solving at the numbers topics; (2) the effectiveness of learning by using mathematics’ worksheets based on problem-solving at the numbers topics. This research was development research with a development model of Dick and Carrey. The subjects of this study are the class VII-B students of Junior High School of Nusantara Lubuk Pakam in the Academic Year of 2018/2019. While the object of this research is a mathematics’ worksheets based problem-solving at the numbers topics. The results of the study stated that (1) mathematics’ worksheets were valid with an average score of 3.95, and (2) learning by using mathematics’ worksheets was effective. The effectiveness of learning by using mathematics’ worksheets is analyzed based on student activity, skills of the teacher to manage learning and students’ problem-solving ability. The average score of student activity was 3.81, the skills of the teacher manage to learn was 4.27, and the percentage average of the problem-solving skills of students was 79.75.

1. Introduction

In everyday life, people often have to solve personal problems they experience. Problems are useful for training one's thinking skills. One of the subjects that can not be separated from problems was mathematics. Mathematics is the basis of all branches of knowledge needed to solve problems [1]. Problem-solving ability is one of the standard processes in mathematics learning [2]. The results of the assessment of education in Indonesia, especially in mathematics, over the years have not shown satisfactory results [3]. This can be known through the results provided by international studies, both the results of the TIMSS study (Trends in International Mathematics and Science Studies) or the PISA (Programme Internationale for Student Assessment) results. Students' mathematical problem-solving abilities in PISA and TIMSS have not shown good results or are still below average [4].

In general mathematical problems are made very difficult, causing students to experience difficulties in completing them [5]. Problems that exist in mathematics require the ability to complete well and correctly. Sometimes the idea of a solution can appear suddenly after struggling with a difficult problem and that can be called insight [6]. The problems that arise in learning mathematics can have an impact on the low learning outcomes. The learning outcomes can be analyzed based on the tests. The low learning outcomes are also related to the learning process and the availability of student learning resources.

To measure how far students understand material or lessons that have been learned, learning tools are needed such as student Mathematics Worksheets. The student Mathematics Worksheet is a teaching material that can be compiled by the teacher itself which presents a problem to measure students’ thinking skills. Bellawati stated that student worksheets are designed so that students can learn independently [7]. In the Mathematics Worksheets is presented place where students write solutions to problems. Through worksheets, student-guided to doing work assignments as activities to
manage students' skills in the classroom guided by the teacher [8].

Based on observations made, many teachers have not designed teaching materials in the form of Mathematics Worksheets in the learning process in the classroom. Most teachers still use questions that come from textbooks or books published. Though it should be the ones who know the cognitive abilities of the students they teach are the teachers concerned. Seeing the many educational problems, especially in mathematics learning, it is very necessary for teacher efforts to minimize them. Therefore we need a research on developing Mathematics Worksheets based on problem-solving on number topics. Numbers are an easy topic. But numbers are one of the foundations of mathematics. Through the results of this study, it is expected to be able to assist teachers in designing their own teaching materials properly and correctly and test the effectiveness of their learning. In addition, students can improve their problem-solving skills specifically on number problems.

2. Research Methods

This type of study is research and development (R & D) with quantitative descriptive methods. In this study, a Mathematics Worksheet was developed. The process of developing a Mathematics Worksheet uses steps in the stages of the Dick and Carrey models. The stages are presented in the following chart:
This research was conducted at Junior High School of Nusantara Lubuk Pakam in the odd semester of Academic Year 2018/2019. The subjects of this study were 36 students of class VII-B. The object of this research is a Mathematics Worksheets on the topic of numbers divided into 8 subtopics. Each meeting is discussed in 1 subtopic. The subtopics in the Mathematics Worksheets were identifying and comparing integers, sum and subtract integers, multiplication and distribution of integers, know and compare fractions, addition and subtraction of fractions, multiplication and division of fractions, positive numbers, and the smallest and smallest guild fellowship factor. Mathematics Worksheets present problems that require problem-solving which include four indicators namely understand the problem, device a plans, carrying out the plan, and checking result [9]. The instruments in this study are validation sheets, observation sheets, and problem-solving skills tests. The validation sheets are used to determine the validity of the Mathematics Worksheets. While the observation sheet is used to measure student activity and the skills of the teacher to manage learning. While the test is used to measure students’ problem solving skills.

The formula for calculating the completeness of individual learning is as follows:

\[ KB = \frac{T}{T_t} \times 100\% \]  
(1)

Remarks:
KB = Learning completeness
T = Number of scores obtained by students
Tt = Total total score

Criteria: 0\% \leq KB < 72\% of students have not finished learning
72\% \leq KB \leq 100\% of students have finished studying

Each student is said to have completed his studies (individual completeness) if the proportion of student answers is correct.

The formula for knowing the completeness of classical learning is as follows:

\[ PKK = \frac{\text{many student to reach } KB \geq 72\%}{\text{many research subjek}} \times 100\% \]  
(2)

Remarks:
PKK = Percentage of classic completeness

Classes are said to be really studied if there are 70\% in the class that has reached KB or at least 70\% of the number of students who achieve the Minimum Completion Criteria specified.

To test the effectiveness of learning by using the Student Mathematics Worksheet, it is analyzed by observing student activities, the ability of the teacher to learn, and students’ problem-solving skills. Student activities, in this case, are activities carried out by students in participating in learning by using Student Mathematics Worksheets which are measured based on student activity observation sheets. Likewise, the teacher’s ability to manage to learn in this case is the ability seen from the activities carried out by the teacher during the teaching-learning process as measured by the teacher’s ability observation sheet. While students’ problem-solving abilities are the values obtained by students from the problem-solving ability tests given after learning by using the Mathematics Worksheet.

3. Results and discussion
The Mathematics Worksheet was developed with the Dick and Carrey model validated by one mathematics teacher and one mathematics education lecturer. Validation results are seen based on the data entry in the validation sheet. The results of the validation of the Mathematics Worksheet based on aspects assessed in 8 subtopics are shown in the following table 1:
Table 1. Result of average validation of mathematics worksheets based on assessed aspects

| No. | Rated Aspect | Average Score | Percentage of Criteria | Percentage of Each Aspect and Category |
|-----|--------------|---------------|------------------------|----------------------------------------|
|     |              |               |                        |                                        |
| 1.  | Format       |               |                        |                                        |
|     | a. Clarity of material distribution | 4 | 80 | 80 | (Very Valid) |
|     | b. Clear numbering system | 4 | 80 | 80 |
|     | c. Room / layout settings | 4 | 80 | 80 |
|     | d. Type and size of letters accordingly | 4 | 80 | 80 |
|     | e. Suitability of physical size Mathematics Worksheet with students | 4 | 80 | 80 |
| 2.  | Language     |               |                        |                                        |
|     | a. The truth of grammar | 4 | 80 | 80 | (Very Valid) |
|     | b. Conformity of sentences with the level of development | 4 | 80 | 80 |
|     | c. Encourage interest in work | 4 | 80 | 80 |
|     | d. Simplicity of sentence structure | 4 | 80 | 80 |
|     | e. The question sentence does not contain multiple meanings | 4 | 80 | 80 | (Very Valid) |
|     | f. Clarity of instructions and direction | 4 | 80 | 80 |
|     | g. The communicative nature of the language used | 4 | 80 | 80 |
| 3.  | Content      |               |                        |                                        |
|     | a. Truth of content / material | 4 | 80 | 80 | (Valid) |
|     | b. Problems are presented according to the level of student cognition | 4 | 80 | 80 |
|     | c. Grouped in logical parts | 4 | 80 | 80 |
|     | d. Its role in encouraging students to solve problems | 4 | 80 | 77.14 | (Valid) |
|     | e. Improve learning completeness | 4 | 80 | 77.14 |
|     | f. Conformity with indicators of the Learning Implementation Plan | 4 | 80 | 77.14 |
|     | g. Suitability of time allocation used | 3 | 60 | 77.14 |
|     | Average percentage validation of Mathematics Worksheets | 3.95 | 79.05 | Valid |

In table 1 above shows the average percentage validation based on three aspects, namely the format is 80, the language is 80, and the content is 77.14. So that the average percentage validation of the Mathematics Worksheet is 79.05 with a valid category. If it is concluded, the results of the validation of the Mathematics Worksheet in 8 subtopics can also be stated as in table 2:

Table 2. Results of validation of mathematics worksheet on the numbers subtopics

| No. | Subtopic of Mathematics Worksheets | Average Score | Validation Results |
|-----|-----------------------------------|---------------|-------------------|
| 1.  | Get to know and compare integers | 3.95          | Valid             |
| 2.  | Addition and subtraction of integers | 3.95       | Valid             |
| 3.  | Multiplication and integer division | 3.95         | Valid             |
| 4.  | Know and compare fractions | 3.95          | Valid             |
5. Addition and subtraction of fractions 3.95 Valid
6. Multiplication and division of fractions 3.95 Valid
7. Positive rounded number 3.95 Valid
8. The Smallest Multiples and the Biggest Guild Factor 3.95 Valid

| No. | Student Activities                                      | Average Score in the Subtopic | Average Score per Activity |
|-----|---------------------------------------------------------|-------------------------------|----------------------------|
| 1.  | Prepare notebooks and textbooks.                       | 3.67 3.83 4.17 4.17 4 3.67 3.83 4 | 3.97                       |
| 2.  | Occupy and occupy the designated place.                | 4.07 4 4.5 4.5 4 4 4 4.5         | 4.2                        |
| 3.  | Follow closely everything that is being conveyed.      | 3.67 3.67 3.5 3.5 3.67 3.83 3.67 4 | 3.7                        |
| 4.  | Students listen to questions or issues related to the lesson. Students think critically in listening to the questions posed by the teacher. | 3.67 3.83 4.6 4 3.83 4 4 3.67 | 4.02                       |
| 5.  | Pay close attention and take notes. Students hold active discussions with group friends. Students try to express their own opinions about what they think also record everything in the discussion. | 4 4.17 4.17 4 4.17 3.83 4 3.83 | 4.02                       |
| 6.  | Students share and work with fellow members in groups. Students were brave and active in expressing their opinions. Students in the group assume that they are as alive and as | 3.83 4 3.83 3.83 3.83 4 3.83 3.83 | 3.87                       |
| 7.  |                                                                                           |                              |                            |
| 8.  |                                                                                           |                              |                            |
| 9.  |                                                                                           |                              |                            |
| 10. |                                                                                           |                              |                            |
| 11. |                                                                                           |                              |                            |

Table 2 above shows that the Mathematics Worksheet developed which consists of eight valid subtopics with the same mean for each subtopic, namely 3.95. So, overall the Mathematics Worksheet developed is valid with a score of 3.95. Thus the Mathematics Worksheet developed is good for use in mathematics learning.

Whereas in testing the effectiveness of learning by using Mathematics Worksheets it is concluded based on observation data on student activities, the ability of the teacher to manage learning, and data on students' problem solving abilities. For the average data of student activities concluded based on observation sheet data where indicators measure student activity there are 17 items of statements with five choices namely covering very bad, not good, less good, good, and very good. There are six study groups formed when subtopic learning takes place. The average observation of student activities per group in learning by using the Mathematics Worksheet is presented in the following table 3:

Table 3. Average observation scores of student activities in learning using the Mathematics Worksheet
Students are responsible for everything in their groups, like their own. Students see that all members in the group have the same goal. Students share the same tasks and responsibilities among group members. Students will be subject to evaluation or given prizes/awards that will also be applied to all group members. Students share leadership and they need skills to learn together during the learning process. Students will be asked to individually account for the material handled in cooperative groups.

| Activity Description                                                                 | Average Scores |
|-------------------------------------------------------------------------------------|----------------|
| 12. Students are responsible for everything in their groups, like their own.       | 3.5 3.5 3.5 3.5 3.5 3.67 3.67 3.5 3.56 |
| 13. Students see that all members in the group have the same goal.                  | 3.5 3.83 3.5 3.5 3.67 3.83 3.83 3.83 3.67 |
| 14. Students share the same tasks and responsibilities among group members.       | 3.67 3.5 3.83 3.5 3.67 3.67 3.67 3.5 3.64 |
| 15. Students will be subject to evaluation or given prizes/awards that will also be applied to all group members. Students share leadership and they need skills to learn together during the learning process. Students will be asked to individually account for the material handled in cooperative groups. | 3.83 3.67 4.17 4.17 4 3.83 3.67 3.67 3.88 |
| 16. Students will be asked to individually account for the material handled in cooperative groups. | 3.67 3.5 3.83 3.83 3.83 3.67 3.67 3.5 3.72 |
| 17. Students will be asked to individually account for the material handled in cooperative groups. | 3.67 3.5 4.33 4.33 3.67 3.83 3.83 3.67 3.85 |

| Average | 3.79 |
| Category | Good |

In table 3 above shows that the average student activity which includes 17 activities measured during learning using the Mathematics Worksheet is 3.79 good category. While the average results of observing student activities based on subtopic 1 to 8 are 3.81. Details of data on average student activity for each subtopic are presented in the following figure 2:

![Average Students Activity](image.png)

**Figure 2. Average student activity for each subtopic**

Figure 2 above shows that the average score of student activity during learning in subtopic 1 is 3.76, subtopic 2 is 3.83, subtopics 3 and 4 are 3.85, subtopics 5 are 3.83, subtopics 6, 7, and 8 are the same ie 3.76. Thus it was concluded that the activities of students in subtopics 3 and 4 were better than other subtopic learning activities.

While the average data of the teacher's skills is concluded based on the results of observers' teacher observations through the observation sheet that was evaluated is the activity of the teacher during the initial activities, core activities, and final activities. Data obtained on average the ability of teachers to manage learn in material 1 to 8 is 4.27 in the good category. Details of the average data for each subtopic are presented in the following figure 3:
Figure 3 above shows the average score of the teacher's ability to manage to learn in subtopics 1, 5, and 7 is the same, namely 4.17. The average scores on subtopics 2, 3, 4, 6, and 8 are the same, namely 4.33. Thus it can be concluded that the average teacher's ability to manage to learn is better at subtopic 2, 3, 4, 6, and 6 compared to other subtopics.

While data on students' problem-solving skills using the Mathematics Worksheet are concluded based on the results of the problem-solving skills test. The problem solving skills test is compiled using four indicators, namely understanding the problem, making plans, implementing the plan, and re-examining the results obtained. Through the results of the test calculated the percentage of completeness of student learning individually and classically. The average percentage of overall learning completeness is 79.75. The average percentage of completeness of learning for each material is presented in the following figure 4:

Figure 4 shows that the percentage of learning completeness in subtopic 1 is 72, subtopic 2 is 80, subtopic 3 is 86, subtopic 4 is 76, subtopic 5 is 81, subtopic 6 and 8 are 85, and subtopic 7 is 73. Thus percentage completeness higher learning in subtopic 3 learning than learning in other subtopics.

So, based on the three indicators measuring the effectiveness of learning by using the student Mathematics Worksheet the results obtained are that the learning done is effective. This is concluded based on the overall average of student activities is good, namely, with an average value of 3.81, the ability of teachers to manage learning is good with an average value of 4.27, and the average overall percentage of learning completeness is good, namely 79.75. If it is concluded based on the subtopic of learning on the three indicators of learning effectiveness, the results show that the effectiveness of
learning in subtopic 3 is higher than learning in other subtopics. However, the effectiveness of subtopic learning 1 is lower than learning in other subtopics.

Through the results of research in the form of developing Mathematics Worksheets based on problem solving, it is hoped that it can be used as a reference that can help teachers in developing valid teaching materials and testing the effectiveness of self-designed teaching materials. This Mathematics Worksheet is certainly very useful especially as a means of training students in solving problems. With the existence of teaching materials in the form of a valid and effective Mathematics Worksheet, it can certainly minimize the learning problems experienced by students, especially those related to students' thinking abilities and activities while studying.

4. Conclusion
This study concludes that Mathematics Worksheets based on problem-solving developed are valid and effective to be applied in mathematics learning on integer topics. It was concluded based on the validation results provided by the validator by assessing the format, language, and content of the Mathematics Worksheet based on the problem solving developed. The results obtained are an average score of 3.95. Likewise learning using Mathematics Worksheets is concluded to be effective based on the average value of student activity which is 3.81, teacher skills managed for learning are 4.27, and the average percentage of students' problem solving skills is 79.75. Therefore, with this research, it is expected that teachers can develop their own Mathematics Worksheets and test the effectiveness of learning using the developed Mathematics Worksheet by concluding it based on student activities, the ability of teachers to manage to learn, students' problem-solving abilities. Furthermore, the researchers suggested that a Mathematics Worksheet be developed on other material and tested its effectiveness as an effort to improve the quality of learning, especially in mathematics.

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