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The development of problem sheets based on model eliciting activities learning to improve students' mathematical communication ability

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Abstract

Problem Sheets are another form of the student worksheet that is arranged specifically in the Model Eliciting Activities (MEAs) learning. Students have to solve some problems in Problem Sheets with mathematical modeling. The purpose of this research was to produce a Problem Sheets based on MEAs learning which was guided by the indicators of students' mathematical communication ability. This research is a type of Research and Development (R&D), the model used in this research is 4D Models consisting of 1) Define; 2) Design; 3) Develop; and 4) Disseminate. However, this research only went through three steps, they are 1) Define; 2) Design; and 3) Develop. The feasibility test result shows the Problem Sheets feasible is used in activities learning with a percentage of 87,11%. In addition, the readability test uses Cochran Test result shows that $Q = 9 < \chi^2_{(\alpha;k-1)} = 16{,}919$. It means the students have the same understanding of the Problem Sheets given. After getting e-copyrights from the Directorate General of the Intellectual Property, the Problem Sheets based on MEAs learning is ready used for the next steps, that is testing in classroom learning.

1. Introduction

Mathematics is a science that is studied at all levels of education. The successful of mathematics learning needs to be supported by adequate learning tools and joyful learning models to improve students' cognitive abilities. Based on a preliminary study conducted at one of the junior high schools in Semarang, it is known that students' mathematical communication ability in seventh graders are still low.

Mathematical communication ability are the ability to convey mathematical ideas into simple language. According to Hendriana et al., (2017) mathematical communication is a basic mathematical ability that is essential and needs to be possessed by high school students. But in fact, students' mathematical communication abilities are still relatively low. This statement refer to the research of Zulkarnain (2013) which states that students have not been able to communicate ideas well, there are students' answers that are wrong to the questions given and the calculation steps taken by students are not well organized and inconsistent.

One of the ways to improve students' mathematical communication ability is to pay attention to the learning model used. Model Eliciting Activities (MEAs) learning which are based on the process of mathematical modeling in solving problems in daily life can lead students to be more active in conveying creative ideas that they have and deepen knowledge by increasing curiosity of material concepts and solutions from a problem. The existence of a group discussion in one of the steps of MEAs learning can facilitate students in the process of improving their communication ability. This statement is supported by

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the study of Anggralia et al., (2019) which states that there is a significant influence on the MEAs learning on students' mathematical communication ability.

Mathematics learning that only uses the textbooks can make students bored. In other side, students couldn't find more information if they only use one learning resource. For this reason, students need a Student Worksheets that can complement classroom learning tools as a textbook companion. The Ministry of Education and Culture (2013) said student worksheets is a worksheet contain assignments that must be completed by students. Besides that, student worksheets also contain learning objectives, instructions for use, and steps for solving the problems. Student worksheets is one of the learning tools used by teacher to increase students' involvement in learning process, both individually and group. MEAs as a learning model also uses Student Worksheets in its steps. Student Worksheets in MEAs leaning are often referred to as Problem Sheets.

Based on the description above, the Problem Sheets in MEAs learning will be arranged based on indicators of students' mathematical communication skills. Therefore, researchers will conduct research on "The Development of Problem Sheets Based on Model Eliciting Activities (MEAs) Learning to Improve Students' Mathematical Communication Skills in Seventh Graders"

2. Methods

This research applies Research and Development (R&D) method with 4-D Models developed by Thiagarajan, Semmel, and Semmel (1974). This study have three steps, they are 1) Define; 2) Design; and 3) Develop. Analyse problems in SMP Negeri 11 Semarang is the first step to solve this problem.

Next, the researcher designed Problem Sheets based on MEAs learning in the Quadrilateral material. This Problem Sheets aims to improve mathematical communication skills in seventh graders. The design of the Problem Sheets was consulted with the supervisor before being validated by three validators. The validation aims to determine the feasibility of the Problem Sheets developed. Furthermore, the readability test was conducted on five students of seventh graders to show whether the Problem Sheets can be easily understood by students. Data analysis techniques for the feasibility of the Problem Sheets are calculated by finding the percentage of feasibility uses the following equation.

$$P = \frac{f}{N} \times 100\%$$

(Sudijono, 2014, p. 43),

where,

P : percentage of feasibility score

f : number of scores obtained

N : the maximum number of scores

The feasibility level criteria for the Problem Sheets according to Akbar (2013) are shown in Table 1.

Table 1. The Feasibility Level Criteria for Problem Sheets

Level of Feasibility	Criteria
$1\% \leq P \leq 50\%$	Not Feasible
$50\% < P \leq 70\%$	Feasible Enough
$70\% < P \leq 85\%$	Feasible
$85\% < P \leq 100\%$	Very Feasible

If the assessment results is >70%, then the Problem Sheets feasible is used in activities learning. Analysis of readability test data uses the Cochran Test with the following formula.

$$Q = \frac{(k-1)[k(\sum_{j=1}^{k} G_j{}^2 - (\sum_{j=1}^{k} G_j)^2]}{k\sum_{i=1}^{N} L_i - \sum_{i=1}^{N} L_i{}^2}$$

with,
k : number of columns
N : number of lines
$\sum_{i=1}^{N} L_i$: total number of successes in line *i*
$\sum_{i=1}^{N} L_i{}^2$: square of the total number of successes in line *i*
$\sum_{j=1}^{k} G_j$: total number of successes in column *j*

(Djarwanto, 2003, p. 70)

Decision making is based on the following hypothesis.
H_0: There is no differences in opinion among the five students regarding their understanding on the Problem Sheets.
H_1: There are differences in opinion among the five students regarding their understanding on the Problem Sheets.
The test criteria used are decline H_0 if $Q \geq \chi^2{}_{(\alpha;k-1)}$ with $\alpha = 5\%$.

3. Results & Discussions

3.1. Define

The initial analysis is to look for a problem in SMP Negeri 11 Semarang. Based on observations, information was obtained that the school had implemented learning uses the 2013 Curriculum. However, the teaching materials used were still inadequate because only textbooks were often used. Teachers also need innovative learning models that can make students not bored when studied at mathematics learning. In addition, teachers want to improve students' cognitive abilities, especially mathematical communication skills that are classified as low.

The results of the initial analysis serve as a reference for developing products adjusted to student characteristics. In other side, Core Competencies and Basic Competencies are examined in depth to determine the concepts and learning objectives.

3.2. Design

One of the contents of the product to be developed is the presentation of practice questions based on indicators of mathematical communication skills, they are written text, drawing, and mathematical expressions (Hendriana et al., 2017). The finally product designed was a student worksheet called Problem Sheets based on MEAs learning in the Quadrilateral material. This Problem Sheets is arranged with an attractive appearance aims to increasing student motivation and learning outcomes (Ismail, 2014). The initial design of the Problem Sheets was consulted before the validation stage.

3.3. Develop

This development steps includes a feasibility test, a readability test, and the giving of the e-copyrights to the Problem Sheets based on MEAs learning in the Quadrilateral material. Validation is carried out by three validators by filling out a validation sheets in the questionnaire form adapted from Badan Standar Nasional Pendidikan (BSNP) or National Education Standards Agency. The feasibility test of the Problem Sheets covers the feasibility of the contents, language, and presentation aspects. Next, the readability test was conducted on five students of seventh graders by giving a questionnaire containing 10 statements. Readability test is conducted to determine whether the material, language, and layout of the Problem Sheets can be used by students to understand the material presented easily (Dewi & Arini, 2018).

The validators provides comments and suggestions before validating the Problem Sheets, that is (1) the supervisors' name is written in the cover of the Problem Sheets; (2) write the narrative texts about the

relationship of the Problem Sheets with MEAs learning; (3) repair the figure of rhombus to be different from the figure of square; (4) change the allocation time to completing the Problem Sheets from 10-minutes to 40-minutes for each meeting; and (5) correct sentences that uses word 'if-then'. Revisions to the Problem Sheets were according to the comments and suggestions of the validators. The results of these revisions can be seen in Figure 1, Figure 2, and Figure 3.

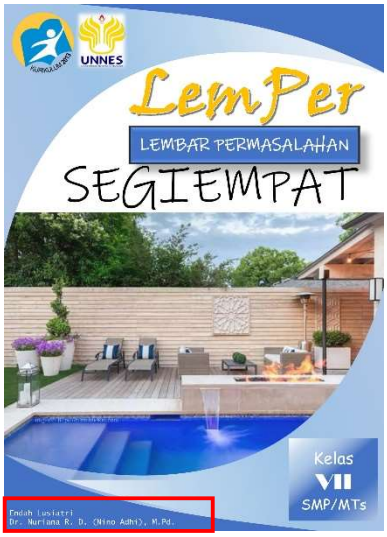

Figure 1. The supervisors' name in the cover.

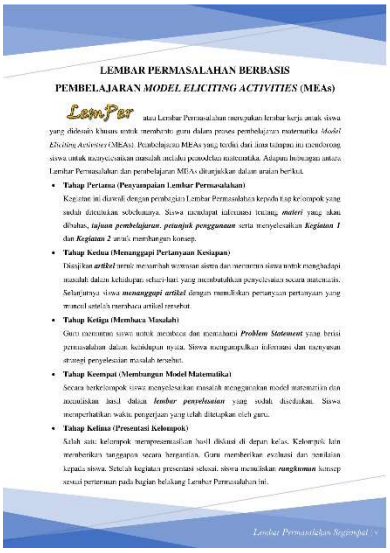

Figure 2. The narrative texts about the relationship of the Problem Sheets with MEAs learning.

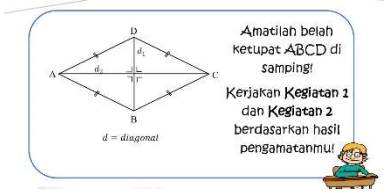

Figure 3. The figure of rhombus after repaired.

The result of the feasibility test of Problem Sheets based on MEAs learning in the Quadrilateral material reached a percentage of 87.11% with the category "very feasible". The feasibility of each aspect is presented in Table 2.

Table 2. The Result of the Feasibility Test of Problem Sheets in Each Aspect

The Observed Aspect	P (%)	Criteria
Content	86,66	Very Feasible
Language	87,17	Very Feasible
Presentation	87,50	Very Feasible

The feasibility test result shows that the Problem Sheets based on MEAs learning in the Quadrilateral material feasible was uses in mathematics learning.

Readability test results obtained by the value of $Q = 9 < \chi^2_{(\alpha;k-1)} = 16{,}919$. This result shows there is no differences in opinion among the five students regarding their understanding on the Problem Sheets. This is refer to Putra (2013) which states that the level of education of the reader, the diction/foreign vocabulary used, as well as the syllables contained in teaching materials are the factors that determine the readability of teaching materials.

After the due feasibility and readability test, the Problem Sheets is rearranged to be given e-copyright. Directorate General of the Intellectual Property published this Problem Sheets based on MEAs learning on July 27, 2020.

4. Conclusion

Based on the results of the study, it can be concluded that (1) the development of the Problem Sheets based on MEAs learning in the Quadrilateral material have three steps, they are Define, Design, and Develop; (2) the feasibility test of the Problem Sheets based on MEAs learning in the Quadrilateral material reaches a percentage of 87.11% which means the Problem Sheets feasible is used in activities learning; and (3) the readability of Problem Sheet based on MEAs learning in the Quadrilateral material using the Cochran Test result show that $= 9 < \chi^2_{(\alpha;k-1)} = 16{,}919$. These results indicate that H_0 is accepted, which means there is no differences in opinion among the five students regarding their understanding on the Problem Sheets.

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