Developing material for promoting problem-solving ability through bar modeling technique

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Abstract. This study aimed at developing material for enhancing problem-solving ability through bar modeling technique with thematic learning. Polya's steps of problem-solving were chosen as the basis of the study. The methods of the study were research and development. The subject of this study were five teen students of the fifth grade of Lab-school FIP UMJ elementary school. Expert review and student’ response analysis were used to collect the data. Furthermore, the data were analyzed using qualitative descriptive and quantitative. The findings showed that material in theme “Selalu Berhemat Energi” was categorized as valid and practical. The validity was measured by using the aspect of language, contents, and graphics. Based on the expert comments, the materials were easy to implement in the teaching-learning process. In addition, the result of students’ response showed that material was both interesting and easy to understand. Thus, students gained more understanding in learning problem-solving.

1. Introduction
One of the objectives of learning Mathematics in school is to solve problems that include ability to understand problems, design mathematical models, solve models, and interpret the solutions obtained [1]. This is because that problem-solving is viewed as a process to find a combination of a number of rules that can be applied in an effort to cope with the new situation. Problem-solving is not merely a form of being able to apply rules that have been mastered through past learning activities, but more than that is the process of obtaining rules at a higher level [2]. According to [3] mentioned that the low ability of problem-solving due to the lessons used by teachers is still dominated by ordinary learning models that give less emphasis on the application of mathematics in everyday life, and students are not accustomed to involved in solving problems. Students tend to solve a problem by mimicking the problem solving that the teacher exhibits when discussing the problems [4].

This is in line with Polya's theory that problem-solving helps students in building their skills, stimulating them to discover new knowledge and actively engaging students in learning activities. According to Polya (1951) problem-solving as a capability includes activities such as [5]; (1) following the step to understand problems that include: identifying known data, identifying the data being asked, identifying necessary data, adequacy of data, and compile a mathematical model of the problem; (2) selecting strategies and executing strategies; (3) implementing calculations and solve mathematical models; (4) interpreting the solution (outcome) to the original problem and checking the correctness of the solution.

Thus, researchers can conclude that solving mathematical problems can help students to improve their abilities, discover new knowledge and play an active role in learning activities. However, the importance of problem-solving skills is not supported by the students' current skills. It is seen that based
on TIMSS data in 2015, the score of problem solving ability of grade 4 of elementary school students is only 397 where the benchmark score is 500.

One of the factors that can lead to the condition is the inappropriate use of learning resources used in schools. In general, the source of learning used is only mechanistic less emphasis on mathematical ability, especially problem-solving. Presentation of learning resources is also still abstract in helping students to understand the problems associated with problem-solving abilities. Therefore, it is necessary to find a source of learning which assist the student in overcoming the problems.

Bar modeling drawing or commonly known as Model Method which is a way of completion developed by the Ministry of Education Singapore since 1980 and has been widely used by other developed countries. This is because the modeling bar gives students a powerful way to model and solve problems related to problem-solving [5]. Furthermore, modeling drawing bars can help students acquire knowledge more meaningfully than using mechanistic means as shown in example 1.

Example : Andi’s age is three years older than Sarah’s age in this year, but two years younger than Heri’s age.

How old is Andi, if the total of their age is 41 years.

1 unit
Sarah’s age
Andi’s age
Heri’s age

3 units = 41 - 2 - 3 - 3
3 units = 33
1 unit = 11 → Sarah’s age
So Andi’s age is = 11 + 3 = 14 years old

The example shows that the drawing model can be interpreted as a form of translating the story into a diagram or the so-called "model".

Based on the arguments and explanation stated above, the researchers are interested in conducting an experiment by using bar modeling technique as a developed supplementary material to students in elementary school in order to help them improve their mathematical problem-solving ability. Thus, the purposes of this study is material development of the problem-solving ability through bar modeling technique with thematic learning

2. Methods

The research method in this study is RnD research. This research method was chosen because the researchers wanted to develop problem-solving mathematics materials of Bar Modelling Drawing. This corresponds to the opinion of Borg and Gall (1988) [7] who stated that research and development (Research and Development) is a research method used to develop or validate the products used in education and learning. Procedures in this development research apply several stages, namely, (1) observing the location of the research, (2) borrowing thematic books, (3) preparing teaching materials, (4) validating the teaching materials to the bar technics modeling experts, material experts, linguists And design experts, (5) testing into small classes, (6) piloting into large classes.

The material product of bar modeling drawing is validated by experts. There are 3 experts who validate the materials bar modeling drawing, namely (1) bar modeling drawing and material experts, (2)
linguists, (3) design experts. In this research, assessors of the quality of teaching materials bar modeling drawing on thematic learning of mathematics can be seen as follows in table 1.

### Table 1. Expert of Material

| Number | Full Name                  | Expert                                      | Institution               |
|--------|----------------------------|---------------------------------------------|---------------------------|
| 1      | Irani Syach, S.Si          | Bar Modeling Expert dan Material Expert     | Sakamoto                  |
| 2      | Wika Sofiana Dewi, M.Hum  | Linguist                                   | Muhammadiyah University   |
| 3      | Khoala Rachman Adzima, M.Si| Design Expert                               | EsaUnggul University      |

After being validated by three experts, the product was revised and tested into a small class of three subjects of fifth grade selected from the lowest, medium and high score. The three subjects were given a product and student response sheets to assess the product made by the researchers. After that, the product was revised again and tested in a large class of 12 students and given student response sheets. The data obtained in this research are qualitative and quantitative data. Qualitative data in the form of responses, criticisms, and suggestions are attached in the assessment form. The resulting data relates to the suitability of the development product being made. Quantitative data are percentages obtained from product assessment questionnaires filled by fifth grade of elementary students.

The instrument used in this research is the assessment form used to obtain an expert's assessment of the quality of bar modeling drawing materials. Product quality is reviewed from several aspects, namely (1) material suitability, (2) bar modeling drawing concept, (3) language suitability for elementary students, and (4) suitability of design and visualization of teaching materials. Another instrument is a questionnaire about the student's response to teaching materials that have been made by researchers.

Data analysis was performed to see the value of each aspect on the assessment form and the student response questionnaire. The data provided by experts is collected and analyzed descriptively. The data provided by the students are collected and analyzed by calculating the average score multiplied by 100% and the result will be analyzed descriptively.

### 3. Result and Discussion

Based on the results of qualitative and quantitative data processing obtained from both the experts and students' responses on teaching materials using bar modeling techniques to improve the ability of mathematical problem-solving, the following data are obtained: (1) Assessment of experts using the assessment scale is the value of 1 to 10, with details that are 1-2 (less once); 3, 4, and 5 (less); 6, 7, and 8 (good); 9 and 10 (very good). Based on the assessment of experts can be summarized as follows as shown in table 2.

### Table 2. Assessment of Expert

| No. | Aspect                  | Skor  | Category | Conclusion                                      |
|-----|-------------------------|-------|----------|------------------------------------------------|--------------------------------|
| 1   | Language                | 7.6 = 8 | Good     | Teaching material worth a trial with a revision |
| 2   | Material and bar        | 8.7 = 9 | Very Good | Teaching material worth a trial with a revision |
|     | modeling technique      |       |          |                                                |
| 3   | Design                  | 6.9 = 7 | Good     | Teaching material worth a trial with a revision |
Example of content of material as shown as below.

![Example of content of material as shown as below.](image1)

![Example of content of material as shown as below.](image2)

![Example of content of material as shown as below.](image3)

![Example of content of material as shown as below.](image4)

Figure 1. Examples of content materials

In addition, based on all assessments of experts, they stated that the teaching materials are declared as valid and easy to implement in the teaching-learning process. The data based on interview of small class shown that the students of each level (high, medium, and low ability) were easy to understand the material and also it could easy to followed the instruction. Therefore, the materials could be implemented in the big class. The data based on students’ responses were obtained as shown as in table 3. Furthermore, the students stated that the teaching materials have an interesting appearance.
4. Conclusion
The result shows that material in theme “Selalu Berhemat Energi” could be categorized as valid and practical. The validity is measured by using the aspect of language, contents, and design. Based on the expert comments, the materials that we developed can be implemented easily in the teaching-learning process. In addition, the result of the students’ response shows that the material is interesting as well as easy to understand. Furthermore, the students have more understanding to learn problem-solving. In conclusion, the material in theme “Selalu Berhemat Energi” deserves to be given to students of the 4th grade.

References
[1] BSNP 2006 Standar Kompetensi dan Kompetensi Dasar SD/MI (Balitbang:Jakarta)
[2] I. Hardini, P. Dewi 2012 Strategi Pembelajaran Terpadu (Teori, Konsep & Implementasi). (Familia: Yogyakarta)
[3] A. Minarni 2003 Pengaruh Pembelajaran Berbasis Masalah Terhadap Kemampuan Pemecahan Masalah Matematis. PROSIDING. 4 10 pp 92-102
[4] U. Sumarmo 2014 Kumpulan Makalah Berpikir dan Disposisi Matematika serta Pembelajarannya (Universitas Pendidikan Indonesia Press: Bandung)
[5] J. Dindyal 2009 Application & Modelling for The Primary mathematics Classroom (Prentice Hall: Singapore)
[6] Sugiyono 2009 Metode Penelitian Kuantitatif, Kualitatif, dan RnD (Alfabeta: Bandung)