The validity of problem solving based teaching material on mathematical literacy in theme integrated learning

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Abstract. The study aimed to produce a valid teaching material of mathematics literacy with problem solving based in theme integrated learning on grade VI of primary school. The teaching material will promoted to be used as a complementary tool in the implementation of 2013 curriculum in classrooms. The study was conducted using the McKenney and Reeves development model. This consists of preliminary study, prototyping, evaluating and revising the prototype and producing the final product. The instruments used in the data collecting process were the validity of the teaching material. The data obtained in this study was quantitative data from validators.

1. Introduction
Mathematical literacy is an ability to use mathematics in the real life, not only about computation or memorizing mathematical facts [1]. It is also an ability to formulate a problem, to solve and to interpret it within a context [2]. The context could be a relation between mathematics and the real life situation. Therefore, mathematics literacy allows students to use mathematics in solving their daily life problems, this can use mathematical concepts, procedures, facts and tools [3]. Mathematical literacy closely relates to “real” problem where a situation involves within the problem. Then, students have to be able to solve the real world problem by using competencies they already got from school experiences. This has a relationship with some skills that need to be acquired by the students in order to survive in a 21st century era. According to [4] critical thinking, problem solving, communication, collaboration, creativity and inovation are important skills in the 21st century era. These skills, known as higher order thinking skills, are the key to open the longlife education and to produce creative results. Those higher order thinking skills will become an intended knowledge of learning and working in the information and technology based era for now and the future.

In general, students’ mathematics competency level in solving literacy based problem is below the average. An indication of this is shown by the result of Trends International Mathematics Science Study (TIMSS) in 2015. The result shown that junior high schools’ students (grade VIII) in Indonesia take the 45th rank among 50 countries. Based on the average score, Indonesia only can collect 397 points out of 500 [5]. In addition, Programme for International Student Assessment (PISA) 2015 also shown a similar result, for mathematical ability, Indonesia took the 65th rank from 72 countries with 386 points [6]. Two domains are used in the problem of the test. They are content/concept and cognitive domain. The content/ concept domain consists of numbers, algebra, geometry and data analysis. The cognitive
domain consists of notion, implementation and reasoning. Those two domains indicate that the problems was developed based on higher order thinking skills.

TIMSS and PISA results, actually, are designed not to test the primary school students' ability. However, we used the results as an additional background information in the present study because it is still relevant to predict the ability of the primary school students. The assumption is the quality of the learning process and the students' achievements in mathematics at primary school will contribute to their achievements in the next level of education [7].

The development of students in a group of 11 – 13 years old's ability in literation also can be seen on the result of a study from [8] who assessed students’ ability related to some skills such as problem solving, representation, manipulation and reasoning. Based on that research, some students’ difficulties in developing their problem solving skills are the use of unsuitable method and solution, they tend to focus merely on the surface of the problem without giving deep attention to the structure of the problem, besides their lack ability on formulizing questions. In addition to that, other factors are misinterpretation of terms, unfully explanation, and the struggle on reporting the result, ineffective use of measurement tools and making an assumption without a clear foundation.

As a response to the aforementioned situation, the Indonesian government has already taken some actions such as forming a task force of Pendidikan Matematika Realistik Indonesia (PMRI) - an Indonesian version of Realistic Mathematics Education (RME). Along with the establishment of the PMRI team, the team also designed PMRI based learning materials and publish it over the country. In RME, which is the basic idea of PMRI, mathematics is seen as a human activity as Freudenthal’s point of view instead of as a subject that should be taught and transferred to the students [9]. There are three basic principles of RME; guided reinvention and progressive mathematization, didactical phenomenology, and self-developed models [10]. Some studies have already conducted in Indonesia by using these three principles of RME within the domestic context [11]–[14]. In addition, Indonesian government also formulates a suitable curriculum to prepare the students to be fit with the future demand. In 2013, the government implemented Curriculum 2013. The change of the curriculum will affect the learning process in the schools where teacher should also be prepared to deliver the learning properly to the students [15]. In accordance with the implementation, the learning process in primary school should be conducted thematically by using a scientific approach. To support the learning, Badan Standar Nasional Pendidikan (BSNP, National Standard Board of Education) published standard books to be used in the classrooms.

We analyzed the BSNP book and also classrooms practices, which is in this study, we only focus on mathematics in grade VI. We found some points as can be described briefly in the following: (1) the proposed problem on the books are still in knowing and understanding level (2) the problem still not yet oriented on the use of mathematics within a context. (3) the learning process still focuses on giving routine mechanism in solving the given problems which mean students have not been facilitated in analysing, evaluating and reasoning, (4) the development of students’ enthusiasm in learning mathematics still at a lower level, (5) the order of mathematical concepts is not based on the difficulty level, (6) there are some overlap standard competences in the themes.

Furthermore, a research [7] about the Higher Order Thinking Skills (HOTS) at SD IT Adzkia shown that students in that school only can solve problems at the level of knowing and understanding. Only about 12.5 % of the students can solve in HOTS category. The skills relate to students’ ability in understanding the mathematical ideas in depth, looking critically at the given data, looking for the ideas beyond the problems, analogy and generalization, reasoning logically, problem solving, mathematical communication and relating mathematical ideas with other topics or subjects.

Based on those analyses, it is important to develop a learning material on mathematical literacy, which also provides students in developing their problem solving skills as a complementary book in the implementation of thematic learning in grade VI of primary school. A learning material will be the source and also the guidance for teachers and students in conducting the lesson, hence it should be well designed and valid [16]. The problem solving will help students to improve their long life education skills which are involving various processes, including analyzing, interpreting, reasoning, predicting,
evaluating and reflecting [17]. In addition, problem solving is an important context for students in learning about numbers and mathematical concepts [18]. The context will motivate students to learn and at the same time a powerful context can lead to a meaningful learning. Some studies prove the effective use of context in supporting teachers and students in learning mathematics [19], [20].

Based on the aforementioned explanation, the aim of this study is to produce a valid prototype of problem solving based learning material on mathematical literacy as a complementary material to be used in curriculum 2013 for Grade VI of primary school.

2. Method
This study is a developmental research which aimed to develop a product. Plomp [21] state that developmental research as a systematic study to design and to develop a product such as program, model, learning materials, teaching and learning strategies and so on, in order to solve complex problems. The present study is developing problem solving based learning material on mathematical literacy to be used as a complementary book for curriculum 2013 in grade VI of primary school.

The development model used in this study follows the process of developmental research in education which is conducted systematically. The development consists of conducting needs analysis, designing and developing a prototype, evaluating and revising the prototype through some cycles until we get our intended product. The design process in the present study used the design research model by McKenney and Reeves which can be seen in Figure 1.

![Figure 1. Generic model for educational design research by McKenney and Reeves[22]](image)

Based on Figure 1, the development model starts with a preliminary research/ a need analysis, continued by designing the prototype of the learning materials, evaluating, until we get the final product. However, in the present article, we only focus on describing the result of the prototyping phase in which we conducted an expert review to validate the prototype of the learning material.

3. Result and Discussion
The validation of the problem solving based learning material on mathematical literacy in primary school was conducted by four validators. The validators come from two expertise; language and mathematics field. According to experts [23] there are some aspects that should be considered in the validation process such as didactic aspect, construct aspect, technical aspect and language aspect. In the present study we adopt those aspects and modify them become the validity of content, presentment, language and the integration of problem solving and mathematics literacy.

In the following is described the result of the validation. First, Table 1 shows the result of the content validation.

| No | Indicators                              | Mean | Category |
|----|----------------------------------------|------|----------|
| 1  | Suitability of content with learning outcomes | 2.8  | Valid    |
| 2  | Accuracy                               | 2.71 | Valid    |
| 3  | The supporting of the learning material | 2.53 | Valid    |
The result in Table 1 shows that in the validation of content eligibility aspect are around 2.5 until 3.00 for each indicator with category valid. In general, the validation of the learning material in this aspect is 2.72 with a valid category. This indicates that the learning material fits with the intended learning outcomes. The accuracy and the supporting materials along with the material updates already designed in a valid criteria.

Second aspect in the validation phase focuses on the learning material presentment. The Table 2 below shows the result of this validation.

| No | Indicators                  | Mean | Category |
|----|-----------------------------|------|----------|
| 1. | Presenting technique        | 2.7  | Valid    |
| 2. | Presenting support          | 2.8  | Valid    |
| 3. | Presenting of the learning  | 3    | Valid    |
| 4. | Completeness                | 3    | Valid    |
|    | **Mean**                    | **2.9** | **Valid** |

Based on Table 2, it is clear that the average of each indicator in the presentment aspect is in a valid category with around 2.7 until 3.00. Specifically, the result in this aspect indicates that the presenting of the designed material uses a proper technique and also provided with appropriate support. In addition, the material designed is also suited the completeness criteria. Generally, the validity of the learning material in this aspect is in a valid category with 2.9 points.

The next aspect that we focus on the validation process is the use of language in the learning material. Table 3 in the following shows the result of the validation.

| No | Indicators                  | Mean | Category |
|----|-----------------------------|------|----------|
| 1. | Simple language             | 3    | Valid    |
| 2. | Communicative language     | 2.8  | Valid    |
| 3. | Interactive language        | 3.3  | Valid    |
| 4. | The order and its thinking flow | 2.5   | Valid |
| 5. | The use of terms, symbols and icons | 2.8 | Valid |
|    | **Mean**                    | **2.88** | **Valid** |

The result in Table 3 illustrates that the average point of each indicator hit the point of 2.88 which mean the language aspect used in the learning material is in a valid category. By looking at the result we know that the use of the sentences in the learning material has already met the standard requirement of using a good and well structured Bahasa Indonesia. The sentences are in a good order, logic and follow the right thinking flow. Moreover, the result also shows that the language used in the learning material is presented communicatively and interactively. This, along with a good use of terms, symbols and icons so hopefully the students will not have difficulties in using it later on.

The last aspect that we validate is the integration of problem solving and mathematics literacy in the learning material. The validation result of this aspect is can be seen in Table 4. The use of mathematics
literacy consists of using mathematics within a real context. The contextual problems are presented attractively in stories, word problems and using pictures to visualize the content or concepts that will be learned by the students. In the presentation of the material, the completeness of information needed is already analyzed therefore it makes students able to formulate the problems.

Furthermore, in the integration, we also focus on the use of appropriate concepts, facts and procedures in solving the problems. The activity in this aspect was designed carefully in order to facilitate students in problem solving. The activities not only for individuals, but also designed to be done in a small group. Further, the group will present their results in a class discussion.

**Table 4. The validation result in integration of problem solving and mathematical literacy**

| No | Indicators                                   | Mean | Category |
|----|----------------------------------------------|------|----------|
| 1. | Problems within contexts                     | 3    | Valid    |
| 2. | Mathematical Problems                        | 2.7  | Valid    |
| 3. | Mathematical results                          | 3.2  | Valid    |
| 4. | The result within context                    | 3    | Valid    |
|    | **Mean**                                     | **2.98** | **Valid** |

In Table 4, it can be seen that each indicator is in a valid category with general mean is 2.98. This indicates that the integration of problem solving and mathematics literacy is valid in the learning material designed.

Based on information about four aspects that we validate above, we can summarize the validation result in Table 5 below.

**Table 5. General result of the learning material validation.**

| No | Aspects                                               | Mean | Category |
|----|-------------------------------------------------------|------|----------|
| 1. | Content                                               | 2.72 | Valid    |
| 2. | Presentment                                           | 2.9  | Valid    |
| 3. | Language                                              | 2.88 | Valid    |
| 4. | The integration of problem solving and mathematics literacy | 2.98 | Valid    |
|    | **Mean**                                              | **2.87** | **Valid** |

4. **Conclusion**

In general, the validation result indicates that the mean of the learning material validation is in a valid category with 2.88. Hence, it can be concluded that the designed material in the present study is valid and can be used for the next phase of the developmental research.

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