Problem Solving-based Learning Materials on Fraction for Training Creativity of Elementary School Students

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Abstract. The aim of this research is to develop problem solving based learning materials on fraction for training creativity of elementary school students. Curriculum 2006 states that mathematics should be studied by all learners starting from elementary level in order for them mastering thinking skills, one of them is creative thinking. To our current knowledge, there is no such a research topic being done. To promote this direction, we initiate by developing learning materials with problem solving approach. The developed materials include Lesson Plan, Student Activity Sheet, Mathematical Creativity Test, and Achievement Test. We implemented a slightly modified 4-D model by Thiagajan et al. (1974) consisting of Define, Design, Development, and Disseminate. Techniques of gathering data include observation, test, and questionnaire. We applied three good qualities for the resulted materials; that is, validity, practicality, and effectiveness. The results show that the four mentioned materials meet the corresponding criteria of good quality product.

1. Introduction

Curriculum 2006 states that mathematics should be taught to all learners in elementary school to equip them with thinking skills, one of them is creative thinking. Creative attribute is important owned by students in accordance with the advance of science, technology, and engineering. It means that every young citizen has to be capable of following the rapid changes of the world, and able to solve the problems they faced in a carefully, properly, and creatively [1]. Mathematics as an intellectual domain stands at or near the top of any hierarchical list of intellectual domains according to the extent to which creativity is evident in disciplinary activity or production [2].

Through learning mathematics, creative thinking can be trained on students, especially elementary school students. Problem solving based learning can be one of the solutions. Problem solving based learning is a student-centered pedagogy in which students learn about a subject by attempting to find a solution to an open-ended problem [3, 4]. In this learning, the quality material availability for the learning supports the achievement of the desired goals. From researchers’ observation most teachers use the existing learning materials provided by the government through the Ministry of Education. But those materials do not purposefully support the training of student creative thinking. To support the proposed learning we decided to develop the materials for helping the students and also teachers implement the instruction in an effective way.

In mathematics, solving problems represents the most effective concept to contextualization and re-contextualization of concepts, to operational and basic mathematical knowledge transfer to ensure a sustainable and meaningful learning [5]. This learning approach is relatively new for low grade students.
Previous educational researches relating to creativity had been done in higher grades because lower grade students were generally considered not able to master this higher thinking skills. In addition, fraction topic for primary school students is one of the difficult topic to study. To respond this challenge, we plan to choose the problems that lead to a meaningful learning for the students. One kind of such problems are open-ended problems. With careful consideration, these problems may encourage students to create their own problem-solving strategies [5]. With the helps of mathematics teacher the students develop positive attitudes towards a recognition of the diverse approaches and strategies to the posed problems [7].

The goals of this research is to provide good quality learning materials for training students to be creative in mathematics learning and problem solving. We adopt the criteria for good quality product proposed by Nieveen [8] that includes validity, practicality, and effectiveness.

2. Method
This research is development research following 4-D model by Thiagarajan et al. [9] which consists of Define, Design, Develop, and Disseminate stages. Learning materials being developed include Lesson Plan, Student Activity Sheet, Mathematical Creativity Test, and Achievement Test. The materials were field tested involving real classroom trials with 30 students, and validity testing in another classroom with 30 students. Data collection techniques used are observation, test, and questionnaire. The main gathered data are analyzed qualitatively and the other quantitatively.

3. Results
Before field testing the materials were appraised by some experts for the validity and theoretical practicality.

3.1. Validity
From the data analysis on validity it shows that all the materials meet the minimum requirement of validity. The results are summarized in Table 1.

| Tools                      | Description                                      |
|---------------------------|--------------------------------------------------|
| Lesson Plan               | Valid and can be used with little revision       |
| Student Activity Sheet    | Valid and can be used with little revision       |
| Mathematical Creativity Test | Valid and can be used without revision       |
| Achievement Test          | Valid and can be used with little revision       |

Based on a classroom trial, all items of the achievement test satisfies the validity criteria as shown in Table 2.

| Test Item | E_{table} | E_{count} | Description | Criteria |
|-----------|-----------|-----------|-------------|----------|
| 1         | 0,361     | 0,549     | Valid       | Average  |
| 2         | 0,361     | 0,643     | Valid       | High     |
| 3         | 0,361     | 0,646     | Valid       | High     |
| 4         | 0,361     | 0,652     | Valid       | High     |
3.2. Practicality
For the practicality, observers reported that both teacher and students were able to do all activities in accordance with the planned activities set in lesson plans and student activity sheets. They agreed on the minimum score of 4 (scale 1-5).

3.3. Effectiveness
Effectiveness of learning materials was determined within three categories; that is, student response, learning achievement, and mathematical creativity.

For eighth aspects of student response, at least 80% of the students are very strongly to agree with the way the learning proceed.

Table 3. Minimum Learning Mastery

| No | Aspect                  | Trial Classroom | Implementation Classroom |
|----|-------------------------|-----------------|-------------------------|
| 1  | Mastering students (#)  | 24              | 27                      |
| 2  | Failing students (#)    | 6               | 3                       |
| 3  | Learning mastery (%)    | 80%             | 81.97%                  |

From Table 3 we can conclude that both trial and implementation classrooms achieved the classical minimum learning mastery (≥75%). Then result student creativity test show in Table 4.

Table 4. Students’ Creativity Scores

| Criteria    | Trial Classroom | Implementation Classroom |
|-------------|-----------------|--------------------------|
| Not creative| 0               | 0                        |
| Average creative | 13          | 4                        |
| Creative     | 17              | 26                       |
| Very Creative| 0               | 0                        |

From Table 4, we know that in trial and implementation classrooms, all students met the minimum criteria of creative. So we conclude that the learning materials was indeed able to facilitate students in training student creativity.

4. Discussion
The results of development learning materials have met the criteria of validity, practicality, and effectiveness. All experts have judged that all materials are valid and usable for the fraction learning with little or without revisions. Learning that have been planned carefully gets students positive response as learning run well and achieved the learning objectives. The learning makes sense for the students and teachers presents it orderly [10].

4.1. Validity
Validity has been verified from the content of lesson plan, student activity sheet, achievement test, and mathematical creativity test. The learning materials meet the validity criteria and can be used with little/without revisions.

4.2. Practicality
Practicality has been seen from step-by-step implementation of the lesson plans. Observation on both classrooms, trial and implementation, reported that there is no step that get score under minimal score
is 4 (scale 1-5). Learning will not digress and proceed orderly if planned well [11]. In learning, teachers only act as facilitators. Learning was emphasized on how teachers encourage and facilitate students in learning process, not on what should be studied by students [9].

### 4.3. Effectiveness

Effectiveness of learning is based on student response, learning outcome, and mathematical creativity test result. Students’ response in trial and implementation classrooms classify into “Very Strong” category, because the average percentage obtained ≥81% for each aspect. It means that students’ response is positive to learn, so students can learn comfortably through problem solving approach and do not feel bored. The students are more actively involved, so more effectively learning occurs [3]. Students from the two classrooms classically achieves the desired learning, as can be seen from the number of students who get learning outcomes higher than minimum learning mastery. Results of students creativity test have met the criteria of Average Creative. Creative students get used to creatively investigating open-ended problems, with many interpretations, ways of problem solving, or answers [2]. Solving open-ended problems allows students to develop creative attitudes and behaviours [6].

### 5. Conclusion

Based on the results and discussion just described, the developed learning materials have shown to be feasible being used for teaching fraction with problem solving approach to train students creativity.

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