

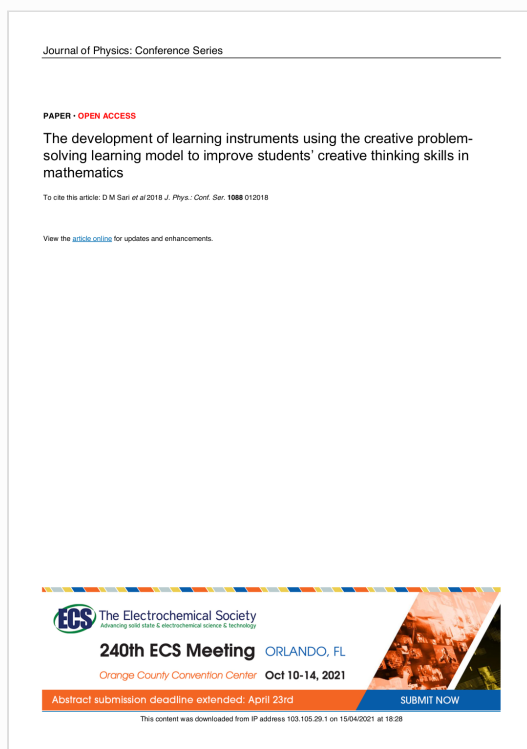


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The development of learning instruments using the creative problem-solving learning model to improve students' creative thinking skills in mathematics

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Abstract. Students should have creative thinking skill in solving mathematics problems by using various alternatives solutions. Unfortunately, many students still have poor quality in creative thinking skill because they have less attention to develop their ability when learning mathematics. One of the efforts to improve students' creative thinking skills is by applying creative problem solving (CPS) learning model. This research aimed to develop the valid and effective CPS learning instruments to improve the students' creative thinking skill by using the development method used a 4D model. There are four stages in the 4D model, including defining, designing, developing and disseminating. However, this research only involved the first three stages. The learning instruments developed were lesson plan, worksheet, and test that covered creative thinking skills. Four validators validated these instruments. The findings showed that all instruments were in a highly valid category, with an average score of 4.1, 4.4, and 4.2 respectively and can be used with minor revisions. Furthermore, the test of creative thinking skills was also classified into the highly valid category with an average score of 4.2 and was ready to be used minor revision.

1. Introduction

Mathematics is taught in each level of education. Mathematics is a universal science underlying the development of modern technology and has an important role in various disciplines and advances the human mind. Mathematics is a branch of systematically organized science [1]. Mathematics needs to be provided to all students starting from elementary school to equip students with logical, analytical, systematic, critical, innovative and creative thinking skills, as well as the ability to work together in a team [2]. However, this research focussed on the creative thinking skill only.

The creative thinking skill plays an important role in the learning of all children and is part of the higher order thinking skills that need to be developed. Creative thinking has had little concern in the mathematics learning. Many teachers only prioritize the logic and computational skill, while creativity is not considered important in mathematics teaching and learning process [3]. However, when students pay attention to the learning process, creativity will enhance understanding and foster the development of students' learning outcomes [4]. Students need to explore their creative potential to deal with various problems of contextual mathematics, which require reasoning, argumentation and creative thinking skills. Both critical and creative thinking skills are crucial to achieve the goals of mathematics



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learning. These skills must be nurtured and cultivated. A more meaningful mathematics learning allows students to ask questions and express their ideas [5]. Recognizing the importance of creative thinking skills, teachers should develop teaching instructions that could help students to improve their higher order thinking skills in mathematics learning.

One of the efforts to improve students' creative thinking skills is by applying creative problem-solving learning model, which refers to the learning model focusing on teaching and problem-solving skills, followed by strengthening the skills. This learning model aims to foster students' interest and motivation in learning mathematics so that students can obtain maximum benefits of learning outcomes [6]. The creative problem-solving model is a framework in which individuals or groups can use to formulate, challenge, generate and analyze new ideas and plan to be implemented to find the solutions [7]. The implementation of creative problem-solving allows students to improve thinking skills, including creative and critical thinking [8]. The creative problem solving is one of the operational model problem solving that require student to apply creativity to complete the given task [9]. It can be inferred that creative problem solving is one of the learning models that can be used to improve students' problem-solving skills by using new ideas and different approaches to solve the problem and plan the effective procedures to find the solutions. This study aimed to develop the valid learning instruments of CPS learning model. Learning instruments developed were lesson plan, student worksheet, and tests of creative thinking skills.

2. Method

In this study, the development of learning instruments used a scientific approach that is relevant to the national curriculum of 2013. This research is classified as the type of development research and used the modified 4D model, including to define, to design, to develop, and to disseminate. However, this study was only conducted in the first three stages of the model. The developed instruments in this study included the lesson plans, student worksheets, and test of creative thinking skill. The subjects of this study were Year 8 students of one of the junior high schools in Banda Aceh.

It is crucial to analyze the quality of the instruments that were developed. The analysis could be assessed from three aspects, namely validity, practicality and effectiveness [10]. This research only focussed on the validity aspect, which involved four validators. The validators were the experts of mathematics teaching and learning, including the two lecturers of mathematics education department and two junior high school mathematics teachers. The used research instruments were validation sheets for the lesson plan, student worksheet, and test. The data the developed learning instruments were analyzed by determining the average of the validity level for each criterion. This analysis involved several phases, including the recapitulation of statements obtained from the validator, finding the average of validity level for each criterion, calculating the average score of each aspect, calculating the total averages, and matching the total averages with the category of validity of a predefined category as can be seen in Tabel 1 [11]. KV is the average score obtained from the experts when validating the learning instruments.

Table 1. The validity criteria of developed learning instruments

Criteria	Average
Highly Valid	$4 \leq KV < 5$
Valid	$3 \leq KV < 4$
Less Valid	$2 \leq KV < 3$
Invalid	$1 \leq KV < 2$

The learning instruments could be used in the teaching practices once they show either "highly valid" or "valid" criteria. However, if the validation results show "less valid" or "invalid" levels, then the revisions on the developed learning instruments are needed.

3. Result and discussion

The recapitulation of the validity scores of the developed learning instruments obtained from the validators is presented in Table 2.

Table 2. The validation results of learning instruments

Learning instrument	Average	Criteria
Lesson plan	4.1	Highly Valid
Student worksheet	4.4	Highly Valid
Creative thinking skills test	4.2	Highly Valid

Based on Table 2, it indicated that the lesson plan was categorized as highly valid with the average score of 4.1 and could be used with minor revision. Similarly, the student worksheet was also highly valid (average score of 4.4) and could be used with minor revision. Also, the creative thinking skills test was highly valid with the average score of 4.4 and could be used with minor revision. These results suggested that all the developed learning instruments were are highly valid; thus they are eligible to be implemented in future teaching instructions. Nevertheless, the validators also provided some feedback that was used to revise the learning instruments. The revisions made for the learning instruments are presented in Table 3.

Table 3. The revision results of the instruments based on validators' suggestions

Aspect	Before validation	After validation
Lesson plan	<ul style="list-style-type: none"> - The revision of language should be made to the lesson plan. - Students should be as the subject rather than as the object on the lesson plan. - The chosen students' name should be based on the common names used in Aceh - Teacher needed to encourage the learning awareness of the relevant knowledge so that students were ready to receive the new material. 	<ul style="list-style-type: none"> - It has been revised, and students are no longer the object but the subject of the lesson plan - Students' names have been revised - The teacher showed the picture and related the picture to the learning objectives of the topics relation and function so that students could identify the concepts of linear equalities and inequalities of two variables
Student worksheet	<ul style="list-style-type: none"> - The colors of the pictures had been similar - The language used had not been communicative - The required students' activities had not been clear 	<ul style="list-style-type: none"> - The colors of the picture were various - The used language was revised - Students' activities were clear
Test questions	<ul style="list-style-type: none"> - The pretest and posttest should be made slightly different not all the pretest, and post-test questions could be understood by using the operation process and graph. - The five items in the test should be checked for their difficulty level due to the limited time. - Item 5 in the post-test should be replaced with a word problem. 	<ul style="list-style-type: none"> - The test questions have been revised, and the pretest and post-test were made slightly different. Not all the pretest and posttest can be understood using the operation process and graph. - The test was revised, and the level of difficulty was evaluated. - Item 5 in the post-test has been replaced with the word problem

Based on Table 3, the results of the revision before and after validation showed the visible improvement. Lesson plan, student worksheet, and test questions were assessed on the indicators suggested by the validators. As suggested in an earlier study, the preparation of learning instruments that can effectively enhance the ability of students' critical and creative thinking is not easy, which would need a research development to retrieve the research-based instruments in improving students' creative thinking skills [12]. The students who can think creatively may have an awareness of the need to develop the sense of curiosity and to stay practicing in solving mathematical problems. This awareness cannot be separated from the learning context that the students engage in which is crucial to develop students' creative thinking and cognitive domains [13]. Another study suggested that to improve students' learning performance and reasoning mathematical skill, the development of the learning instruments that are highly valid, practical, and effective is needed. The products of the development could be in forms of the lesson plans, student worksheets, or the assessment instrument that are worth using in teaching and learning activities [14].

4. Conclusion

The development of learning instruments in this study that employed creative problem solving (CPS) model to improve the creative thinking skills resulted in the highly valid learning instruments. This result is indicated by the average validation scores of the experts that showed that: the lesson plan was a highly valid category (the score was 4.1) and can be used with minor revisions. Also, both student worksheet and the test of creative thinking skills had highly valid criteria (with the scores of 4.4 and 4.2 respectively) and could be used with minor revisions. This research implies that creative problem-solving model could also be used in other research to develop learning instruments. Besides, this research is limited to the topics of relation and function, which means that the development of learning instruments to improve creative thinking skill by CPS model could also be applied to other topics.

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