DEVELOPMENT OF OPEN-ENDED PROBLEM BASED-STUDENT WORKSHEETS TO IMPROVE STUDENTS' CREATIVE THINKING ABILITY

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Abstract *: This study aims to develop open-ended problem-based Student Worksheets to improve creative thinking skills in a valid mathematics course for junior high school and implementation of field trials using Student Worksheets that are developed effectively with the output of open ended problem-based Student Worksheets. The development procedure uses the model developed by Borg and Gall which consists of 10 stages. However, this study only reached the 5th stage, namely (1) Collecting Research and information, (2) Planning, (3) Developing a preliminary form of product, (4) Testing the preliminary field, and (5) Revising the main product. Student Worksheet (SW) that has been developed has gone through a validation process determined by experts or experts in their fields. The average score given by the validator is 4.60 out of a maximum score of 5. Learning by using an open ended-based Student Worksheet to improve creative thinking skills in mathematics courses for junior high school generates effective learning based on (1) the average grade of class students The experimental class reached more than the KKM, namely 85.79 so that the experimental class was completed classically. (2) the results of student achievement in the experimental class are better than in the control class. The values obtained were 85.79 for the experimental class and 66.93 for the control class. Based on the results of the valid and effective learning tools mentioned above, the development of learning tools achieves the desired results, which are feasible to use.*

Key Words*: Creative Thinking; Open Ended; Research Development; Students Worksheet*

Introduction

Student Worksheet is a learning tool as a means of supporting the implementation of learning. The use of Student Worksheet (SW) will open the widest opportunity for students to actively participate in learning. The role of the teacher as a facilitator cannot be replaced by an SW. In using the SW, the teacher is responsible for monitoring student activities during the learning process. Student Worksheets in learning are one of the tools that can be used by lecturers to help students find a mathematical concept and at the same time improve students' problem-solving abilities. Therefore, the SW should be structured so that it does not impede student creativity.

Learning with an open-ended problem approach begins by giving open problems to students. This learning activity must be able to direct and lead students to answer problems in many ways or with many correct answers. This is intended to stimulate students' intellectual abilities and student experience in the process of discovering something new and aims to communicate student creative activities through the learning process. The purpose

of open-ended problem learning according to Moate (2021) is to help develop creative activities and students' mathematical thinking through simultaneous problem-solving. So the essence of open-ended problem learning is learning that builds interaction activities between mathematics and students so that it invites students to answer problems through various ways or strategies.

There are similarities to the notion of open-ended problems. Munroe (2015), Keh, L.K (2016), and Emara (2021) stated that open-ended problems are questions that have more than one correct solution. In addition, Randles (2018) also stated that open-ended problem questions are often interpreted as questions that have more than one correct answer. Students answer questions in their own way that does not follow the process of working on existing answers.

Learning that uses open-ended problems requires Student Worksheets that are based on open-ended problems. The problems given to SW is open-ended problems or incomplete problems. Open-ended problem-based student worksheet in mathematics learning will provide opportunities for students to gain knowledge or experience finding, recognizing, and solving problems in several ways or the problem has many correct answers. SW based on open-ended problems can also provide ideas for students to develop new problems, namely by changing the conditions of previous problems. This SW requires students' creativity in answering them. Each student can answer the problem in his own way. This means that each student's creativity can be expressed so that students have a deeper opportunity to use their mathematical knowledge and skills as a whole.

Gofur, W. A. O., et al (2021) define creative thinking ability as a way to see and solve problems from foreign perspectives, avoid orthodox solutions and think outside the box. This creative process allows you to find connections, take on new challenges, and seek unconventional, original, and new resolutions. According to Silva, H., et al (2022) mathematical creative thinking refers to the ability to produce new, varied solutions to open mathematical problems. From some of these opinions, it can be concluded that the ability to think creatively mathematically is a person's ability to develop ideas and solve mathematical problems in an original, flexible, flexible, elaborative way, and assess through the process of expressing conjectures about cause and effect in a mathematical situation, trying and retry the conjecture and make changes or modifications and finally notify the results.

Silver (1997) explained that assessing the creative thinking ability of children and adults can be done using The Torrance Test of Creative Thinking (TTCT). The three components used to assess creative thinking skills through TTCT are fluency, flexibility and novelty. A more detailed definition is as follows.

1. Fluency is if students are able to solve mathematical problems with several alternative answers (various) and correct.
2. Flexibility is if students are able to solve mathematical problems in different ways.
3. Novelty is if students are able to solve math problems with several different answers but correct value and one answer that is not usually done by students at their stage of development or level of knowledge.

Research on learning with an Open-Ended approach in an effort to improve mathematical connection skills by Yaniawati (2013) found that the open-ended approach can encourage students to face challenges, develop creativity and contribute to students' conceptual understanding. Ali D (2021) in his research states that mathematics learning with an open-ended approach has an effect on increasing students' creative thinking skills and self-regulated learning, the open-ended approach is higher in improving students' creative thinking skills compared to using conventional approaches, Ningsih Research, WE., et al (2020) about the Open Ended learning model as a solution to maximize elementary students' mathematics learning outcomes, giving students a lot of experience in interpreting problems. Another study by Juwita, R., et al (2019) who developed SW based on the Open-Ended approach to improving students' creative thinking skills was valid and found out how the practicality test on SW users proved valid and practical according to the criteria that had been set.

Method

This research is development research by adapting the method of Borg and Gall (1983) which includes 10 stages, but in this study only up to the fifth stage, namely: (1) Research and information collecting, in this stage what is done is conducting a literature study that underlies the learning product that will be developed by reviewing some relevant previous research results to be used as a reference. (2) Planning, after the preliminary study is carried out, the next step is to design activities and procedures to be taken in developing learning products. (3) Develop a preliminary form of product, an initial draft of the Open-Ended problem-based Student Worksheet product that has been made then validated and revised based on expert input so as to produce a revised draft 1. (4) Preliminary field testing, in this stage is to obtain a description the background/setting of the application or feasibility of a product in this case the Open-ended problem-based Student Worksheet. (5) Main product revision. The activity at this stage is to correct the weaknesses in Draft 1 based on the results of a limited trial so as to produce product improvements called Draft 2.

The development carried out is the development of Open Ended Problem-based Student Worksheets to improve creative thinking skills in Junior High School Mathematics Courses. The population in this study were all second-semester students of the Mathematics Education Study Program, Universitas PGRI Semarang. Sampling of research data using purposive sampling technique and taken two classes. The data collected in the development of the Open-Ended Student Worksheet in the form of quantitative data as main data and qualitative data in the form of suggestions and input from respondents as additional data. The data provides an overview of the feasibility of the product being developed. The developed instruments and products used were validated by material experts and media experts. Products that have gone through expert testing will be revised to be more effective and as expected based on a rational assessment carried out by experts.

Product testing is an activity to assess the product in terms of usage. The assessment at the product trial stage is intended to determine the existing field facts and the success of the Student Worksheets made.

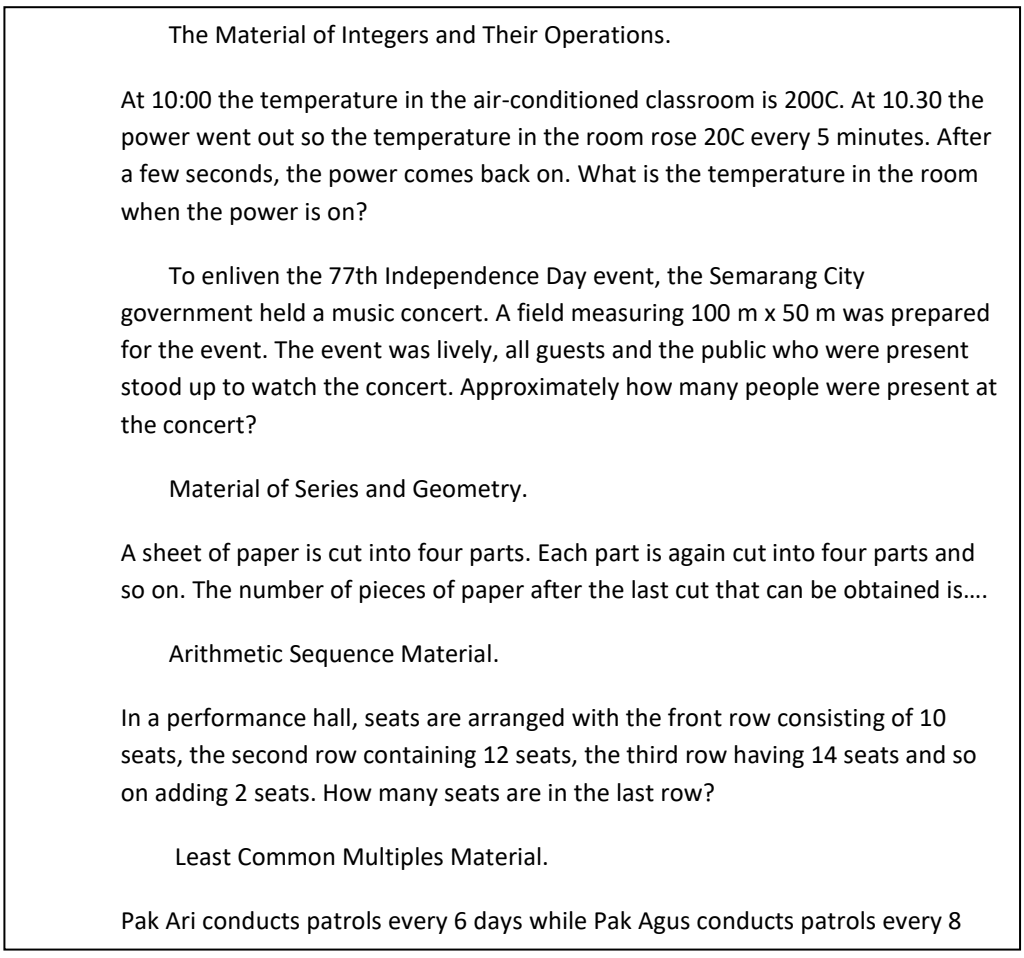
Results and Discussion

Research and Information Collecting Stage

In this stage, the researcher conducts a literature study that underlies the learning product developed by reviewing the relevant previous research results to be used as a reference. The references used by researchers are in the form of scientific articles and other literature studies.

Planning Stage

After the preliminary study is carried out, the next step is to design the activities and procedures taken in the development of learning products. Figure 1 below is a question on the SW before being validated.



The Material of Integers and Their Operations.

At 10:00 the temperature in the air-conditioned classroom is 200C. At 10.30 the power went out so the temperature in the room rose 20C every 5 minutes. After a few seconds, the power comes back on. What is the temperature in the room when the power is on?

To enliven the 77th Independence Day event, the Semarang City government held a music concert. A field measuring 100 m x 50 m was prepared for the event. The event was lively, all guests and the public who were present stood up to watch the concert. Approximately how many people were present at the concert?

Material of Series and Geometry.

A sheet of paper is cut into four parts. Each part is again cut into four parts and so on. The number of pieces of paper after the last cut that can be obtained is….

Arithmetic Sequence Material.

In a performance hall, seats are arranged with the front row consisting of 10 seats, the second row containing 12 seats, the third row having 14 seats and so on adding 2 seats. How many seats are in the last row?

Least Common Multiples Material.

Pak Ari conducts patrols every 6 days while Pak Agus conducts patrols every 8

Figure 1. Questions on the SW Before Being

Preliminary Form of Product Development Stage

The initial draft of the Open-Ended problem-based Student Worksheet product that has been made is then validated and revised based on expert input so as to produce a revised draft 1. Validation is carried out by three competent people to assess the feasibility of the Student Worksheet. Revisions are made based on suggestions or instructions from the

validator. Suggestions from the validator include questions made based on indicators of creative thinking skills, questions that are made should be problems that are usually faced by students in everyday life, there are no working instructions. Suggestions and input from the validator are then used to revise the draft of the Student Worksheet that was previously made. The results of expert validation of the Open-Ended problem-based student worksheets to improve creative thinking skills in the Junior High School Mathematics Course are shown in Table 1 as follows.

Table 1. Recapitulation of Validator Assessment of Learning Tools

No	Description	Score		
		Validator 1	Validator 2	Validator 3
1	SW Organization			
	1. Basic Competence	5	5	5
	2. Learning Indicator	5	5	5
	3. Discussion/Work Instructions	4	3	4
	4. Problem	4	4	5
2	The description of SW material series			
	1. Conformity with Learning Objectives	5	4	5
	2. Readability	4	5	5
	3. Material Recognition and Discovery	4	5	4
	4. Conformity with Creative Thinking Ability Indicators	4	4	5
3	Language			
	1. Using the language according to the correct Indonesian language grammar	5	5	5
	2. The language used is easy to understand	5	4	5
	3. Systematic Language Organizing	5	5	5
	TOTAL	50	49	53
	AVERAGE	4,54	4,45	4,81
	TOTAL AVERAGE		4,60	

From Table 1 it can be seen that the total average value given by the validators is 4.60 from the maximum value of 5. The results of the revision based on the validators' assessment produce draft II which is ready to be implemented in limited trial activities, and can be seen in Figure 2 below. This is a SW after receiving input/suggestions and validation from the validator.

The Material of Integers and Their Operations.

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Figure 2. Questions on the SW After Being Validated

Preliminary Field Testing Stage

In this stage, it is to obtain a description of the setting for the application or feasibility of a product, in this case the Open-ended problem-based Student Worksheet. This preliminary trial is limited in nature, involving only two classes of Mathematics Education Study Program, Universitas PGRI Semarang. In a limited trial activity, one of which is a completeness test. Based on the test scores in the experimental class, a classical completeness test was conducted using the two-party average test. The statistical hypothesis is as follows.

H_0 : ⌠ = 73 (The average value of student learning achievement is equal to 73)

H_1 : ⌠ ¯73 (The average value of student learning achievement is not equal to 73)

From this data, the classical completeness test data analysis was carried out using the One Sample Test and the results were obtained as can be seen in Table 2 below.

Table 2. One-Sample Test

	Test Value = 73					
					95% Confidence Interval of the Difference	
	T	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Score_TPB_Eks	6.524	31	.000	12.438	8.55	16.33

Because the value of sig = 0.000 = 0% < 5%), then H0 is rejected. This means that the average student score is not equal to 73. Furthermore, to find out that the average value of the experimental class completeness is more than 73, see Table 3 below.

Table 3. One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Score_TPB_2A	32	85.79	10.785	1.907

Because the average value of the mean = 85.79, the average value of learning completeness in the experimental class is more than 73. This value shows the average test score is more than the criteria for completeness so that it can be concluded that learning achievement is complete. To determine which class has a higher average value, Group Statistics analysis is used which can be seen in Table 4 below.

Table 4. Group Statistics

	Kelas	N	Mean	Std. Deviation	Std. Error Mean
Pres_bel	2A	32	85.79	10.785	1.907
	2C	32	66.93	11.557	2.043

By looking at the average learning achievement in the mean column, the Group Statistics table obtained 85.79 for the experimental class and 66.93 for the control class. These results indicate that the learning achievement of the experimental class is better than the control class.

Main Product Revision Stage

The activity at this stage is to correct the weaknesses in Draft 1 based on the results of a limited trial to produce product improvements called Draft 2. Student Worksheets based on open-ended to improve creative thinking skills in junior high school mathematics courses have fulfilled two things, namely valid learning tools and effective learning. Effective learning can be seen from (1) learning meets completeness (2) student learning achievement using an open-ended-based Student Worksheet is better than student learning achievement using conventional learning. This is in line with the research conducted by Ali, D (2021) in his research entitled Literature Review: Mathematical Creative Thinking Ability, and Students' Self-Regulated Learning to Use an Open-Ended Approach. then students who get conventional learning. Ningsih, WE., et al (2020) research on the Open-Ended learning model as a solution to maximize elementary students' mathematics learning outcomes gives students a lot of experience in interpreting problems. Research on the development of teaching materials for Mathematics subjects through the presentation of open-ended problems conducted by Soeyono (2014) proved to be effectively used to improve the critical and creative thinking skills of high school students.

Conclusion

Based on the process of developing open-ended-based Student Worksheets to improve creative thinking skills in junior high school mathematics courses that have been carried out, it can be concluded (1) The process and results of developing open-ended problem-based Student Worksheets to improve creative thinking skills in junior high school mathematics courses is valid, (2) learning mathematics with open-ended problem-based Student Worksheets to improve creative thinking skills in junior high school mathematics courses produces effective learning.

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