Tarbawi: Jurnal Ilmu Pendidikan
p-ISSN:1858-1080 |e-ISSN: 2615-6547
Vol. 17, No. 2, December 2021, 184-192

The Visual Media-Assisted Problem-Based Learning Model: Does It Affect Students' Mathematical Critical Thinking Skills?

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Abstract. *This study aims to determine the effect of the Problem-Based Learning model assisted by visual media on student learning outcomes on a Similarity topic. This research is experimental research using a randomized pretest-posttest control group design. The population used in this study were ninth-grade students of one of the junior high schools in Kerinci, Jambi. The sample selection used a random sampling technique. Research data was obtained through pretest and posttest. The results showed an effect of the Problem-Based Learning model assisted by the visual media on student learning outcomes on Similarity topics at the 95% confidence level.*

Keywords*: Mathematical Critical Thinking Skill, Problem-Based Learning Model, Similarity Topic, Visual Media*

INTRODUCTION

Mathematics is a compulsory subject that is always present at every level in primary and secondary education. Mathematics is not only limited to a set of rigid knowledge, definitions, and theories but can also be used to solve various human problems (Ningsih, 2019). This importance is because learning mathematics can train students' thinking skills. In addition, the primary purpose of learning mathematics is to familiarize students with being able to think logically, critically, and systematically (Syahbana, 2012).

Critical thinking ability is a person's skill or skill in weighing and analyzing a problem to obtain conclusions that are the solution to the problem and explain the origin of the conclusions obtained. This statement is in line with Saputra's (2020) statement that critical thinking involves inductive thinking skills such as recognizing relationships, analyzing open-ended problems, determining cause and effect, making conclusions, and taking relevant data into account. Critical thinking skills can not only help solve problems in mathematics but can also help someone in solving everyday problems. Students with critical thinking skills have a flow of thinking that can solve various problems.

Critical thinking skills are included in high-level abilities that cannot exist by themselves in a person. To acquire the ability to think critically, one must be through the educational process, especially in learning mathematics in schools. According to Abdullah (2013), critical mathematical thinking is a mental activity in the field of mathematics carried out using the scientific method steps. Mathematical critical thinking ability can help a student's learning fluency so that it is expected to obtain optimal learning outcomes.

The facts show that critical thinking skills still need to be improved. Previous research by Nuryanti et al. (2018) and Pertiwi (2018) shows that students' critical thinking skills are still low.

The same was also found at one of the junior high schools in Kerinci. Based on interviews with one of the mathematics teachers, the students had difficulty solving questions that required explaining the reasons for an answer given, such as questions with the form of the question "why?", "give a reason!" and similar questions that require optimal brain performance to answer these questions. A preliminary study was conducted by conducting an initial critical thinking ability test for ninth-grade students to strengthen the results of the interviews mentioned above. The percentage of test results is shown in Table 1.

Table 1. Percentage of Initial Critical Thinking Ability Test Results for the Ninth-Grade Students

No.	Critical Thinking Indicator	Students Score		
		1	2	3
1.	Interpretation	48.57%	30.00%	21.43%
2.	Analysis	51.43%	32.86%	15.71%
3.	Evaluation	55.71%	35.71%	8.57%
4.	Inference	52.86%	28.57%	18.57%

One of the causes of the problem of low critical thinking ability is the selection of an inappropriate learning model. The learning that teachers have often applied is direct instruction. In direct instruction, students are not actively building their knowledge (Sundawan, 2016) even though the teacher demonstrates the knowledge and skills that will be trained to students gradually (Panjaitan, 2016). In every learning activity, the teacher should involve all students so that students can participate in discussing the material discussed (Ulandari et al., 2019). Therefore, the teacher should choose a learning model that can facilitate students to be directly involved in acquiring knowledge during the learning process.

Teachers can use a learning model that can increase student activity in learning to improve students' mathematical critical thinking skills, namely the *Problem Based Learning* (PBL) learning model. Following what was stated by Susilawati et al. (2017), an innovative learning model that can enable students to apply their knowledge in dealing with everyday problems and attract students to participate in the learning process actively is a problem-based learning model or PBL. PBL provides opportunities for students to participate actively in the learning process (Noer & Gunowibowo, 2018).

Giving problems at the beginning of learning will encourage students to solve the problems given by analyzing, criticizing, and drawing conclusions to train them in mathematical critical thinking skills (Jumaisyaroh et al., 2015). According to Lidinillah (2013), problem-based learning has advantages and disadvantages. However, as long as the assumptions can be met, problem-based learning is feasible to be applied to create students with a critical mindset toward the problems they face.

In addition to choosing a learning model, teachers can also use learning media so that students can understand a concept that was initially abstract to become concrete. One of the media that can be used as learning media is visual media. Based on research by Arita (2017), visual media can improve students' mathematics learning outcomes. The same result was also found by Nengsih et al. (2018) about the significant influence of the use of visual media on mathematics learning outcomes. Visual media are media that involve sensing. According to Hamiyan and Jaihar in Hermawan (2017), visual media is a tool to convey messages or information to students based on the sense of sight, such as photos, drawings, paintings, sketches, line drawings, symbols, or moving images without sound.

The visual media used in this study is a non-projected visual media of reality. Non-projection visual media is a simple media that does not require a projector to help display an object. Non-reality visual media projections are media that come from objects around them. The advantage of this reality media is that it can provide authentic experiences to students.

Several studies prove that PBL positively influences student learning outcomes (Ratnawati et al., 2020; Nurlaeli et al., 2018; Sianturi et al., 2018). However, no research has been found that combines PBL and the use of visual media. Therefore, this study aims to examine the effect of the Problem Based Learning (PBL) learning model accompanied by the use of visual media on students' critical thinking skills.

METHOD

Experimental research can be interpreted as a research method used to find the effect of cause and effect between variables (Sugiyono, 2017). This study uses a quantitative method with an experimental approach. The research used was a *randomized pretest-posttest control group design*, as shown in Table 2.

Table 2. Randomized Pretest-Posttest Control Group Design

Groups	Pretest	Treatment	Posttest
Experiment	T_1	X_1	T_2
Control		X_2	

Information:
T_1 = The initial test in the experimental and control groups.
X_1 = Problem Based Learning (PBL) learning model assisted by visual media
X_2 = Direct Instruction
T_2 = The final test in the experimental and control groups.

The sampling technique used in this study is random sampling. Before random sampling, the homogeneity of variance test and the average similarity test were carried out on students' semester scores. After it is known that the data has homogeneous variance and has the same average, then a random sample is taken. IX A was selected as the experimental group, while IX B was the control group.

The data collection technique in this study was a test. Before the test was given to the experimental and control groups, the expert validated the test items first. After that, a test trial was carried out in IX C. The trial results were analyzed to obtain questions that met the criteria for use. In this study, the test given was in the form of a mathematical critical thinking ability test consisting of 5 questions. The test questions were given to the experimental group students and the control group students. The following is a rubric or guideline for scoring critical thinking skills in Table 3, adapted from Karim & Normaya (2015).

Table 3. Mathematical Critical Thinking Scoring Rubric

Mathematical Critical Thinking Indicators	Criteria	Score
Interpretation	Thoroughly understand the problem indicated by writing down what is known and asked.	2
	Only understanding incomplete problems are indicated by writing what is known or being asked.	1
	Do not understand the problem, indicated by not writing down what is known or asked.	0

Mathematical Critical Thinking Indicators	Criteria	Score
Analysis	Make a mathematical model of the given problem by producing the correct answer.	2
	Make a mathematical model of the problem that is given but not entirely correct.	1
	Do not make a mathematical model of the given problem.	0
Evaluation	Students use strategies (formulas or steps) appropriately and correctly in solving problems and producing correct calculations.	2
	Students use strategies (formulas or steps) incorrectly and incompletely in solving problems.	1
	Do not use a strategy (formula or step), or the strategy used is not following the given problem.	0
Inference	Make the proper conclusion according to the correct answer.	2
	Making an incorrect conclusion does not match the answer.	1
	No conclusions.	0

The effect of critical thinking skills on students in the learning process by applying the PBL learning model as the experimental group and those applying the direct instruction model as the control group can be seen by comparing the increase in ability which is higher/better between the two groups. First, look for the value of N-Gain or normalized gain of the two groups. The criteria for the N-Gain value can be seen in Table 4.

Table 4. Criteria for N-Gain Value (Lestari, 2015)

Value	Criteria
N-Gain ≥ 0.70	High
0.30 < N-Gain < 0.70	Moderate
N-Gain ≤ 0.30	Low

After obtaining the N-Gain value from the two groups, the normality test was carried out using Shapiro-Wilk. This test was used due to the number of samples used from experimental and control groups being less than 50. After the normality test, the homogeneity test was carried out and continued with hypothesis testing using a t-test to the N-Gain value. Decision-making is done by looking at the probability value (sig). If the probability (sig) > 0.05, then H_0 is accepted, and if the probability value (sig) < 0.05, then H_0 is rejected (Siregar, 2015). Data analysis using SPSS software.

FINDINGS

The research data were obtained by giving questions at the *pretest* and the *posttest*. The questions given at the *pretest* and *posttest* are the same, totalling five questions. The test results given are assessed based on the assessment rubric with a maximum score of 40 with a minimum score of 0. The test is followed by the sample group, namely 23 students for the experimental group and 23 for the control group. The following are the results of the *pretest* and *posttest* of the experimental and control group students.

Table 5. The Average Score of Critical Thinking Skills

No.	Group	Average Score	
		Pretest	***Posttest***
1.	Experiment	5.00	36.00
2.	Control	4.85	31.70

Average N-Gain

The following is given the average value of N-Gain as an illustration of the increasing critical thinking skills of students in the experimental and control groups.

Table 6. The Average of N-Gain of Experimental and Control Group

No.	Group	Average N-Gain
1.	Experiment	0.8819
2.	Control	0.7665

The average N-Gain value obtained for the experimental group is 0.8819, and the control group is 0.7665, which is included in the high criteria. Descriptively the increase in ability for the experimental group is better than for the control group.

Normality test

Table 7. The Results of N-Gain Normality Test

	Group	Statistics	df	Sig.
N-Gain	Experiment	.929	23	.105
	Control	.933	23	.127

Table 7 above is the result of the N-Gain normality test using Shapiro-Wilk. From the normality test results, the sig N-Gain level for the experimental group is 0.105, and the sig N-Gain value for the control group is 0.127. These results conclude that the data for the experimental and control groups are normally distributed because the significance value is more significant than 0.05.

Homogeneity Test

Table 8. The Results of N-Gain Homogeneity Test

	Levene Statistics	df1	df2	Sig.
N-Gain	2.424	1	44	.127

The results of the N-Gain homogeneity test were carried out for both groups, and the results obtained were a significant value of 0.127. This value was greater than 0.05, so it can be concluded that the data for both the experimental and control groups were homogeneous or the same.

Hypothesis testing

Table 9. The Results of Hypothesis Test

		t-test for Equality of Means		
		t	Df	Sig. (2-tailed)
N-Gain	Equal variances assumed	3,531	44	.001

Based on Table 9, the significance value is smaller than 0.05, which means that there is an influence on students' critical thinking skills who, in the learning process, apply the PBL learning model assisted by visual media.

DISCUSSION

The results showed that the learning process that applies the PBL learning model to the subject matter of similarity affects students' critical thinking skills. This finding is because of increased students' critical thinking skills with PBL learning assisted by visual media to accommodate the improvement of every indicator of critical thinking ability. According to Facione in Zetriuslita et al. (2016), the indicators of critical thinking skills are interpretation, analysis, evaluation, conclusion, explanation, and self-confidence.

The PBL model learning process begins by presenting real problems. Following the initial step of PBL learning in the form of orienting students to problems, students are invited to actively observe a problem so that it can stimulate students to recognize the problem and think about what is needed to solve the given problem. This treatment can improve students' critical thinking skills on indicators of interpretation.

In the second and third PBL learning steps, students are organized into several groups and are guided in gathering information from existing problems. Then students discuss the findings of each individual in the group to find the right solution to the problem at hand. Through group collaboration in the investigation process to collect information, it can improve students' critical thinking skills, especially on analytical indicators.

The next step of PBL learning is the fourth and fifth. Students present the results of discussions and evaluations. Students are allowed to present the results of their discussions in front of the classroom and provide conclusions from group discussions. To arrive at this stage, students first choose the right strategy that each individual has put forward to serve as a strategy in solving existing problems so that they can give reasonable conclusions that have been through a process of consideration through group discussion. This treatment can improve evaluation indicators and inference/conclusions on critical thinking ability indicators. As stated by Purwati et al. (2016), the evaluation indicator uses the right strategy in solving problems, while inference is the ability to conclude.

Furthermore, for indicators of explanation or explanation and self-confidence, it means explaining what they think and how they arrive at the conclusions obtained at the time of inference (Karim & Normaya, 2015). Explaining and confidence indicators can also be trained when carrying out the fourth and fifth PBL learning steps.

The application of the PBL learning model needs attention to the material to be delivered to be adapted to the activities in the PBL model itself because this PBL model uses real-life problems as something that students must learn to train and improve their thinking skills. Hermawan (2017) said that in the PBL model's learning process, students begin with real problems that occur in everyday life.

Students who learn to work together in groups will have better skills than those who study alone, and they can practice their thinking skills, especially critical thinking. This situation follows the research of Setyorini et al. in Rachmawati et al. (2015), which states that through PBL with heterogeneous groups, students can exchange ideas and work together to solve problems which in turn can improve critical thinking skills.

In contrast, direct instruction usually refers to lecture learning. Shows that the level of student passivity is higher in the application of direct instruction because students play more of a role as recipients than as information processors. Although in learning, the teacher aims to invite

students to be active in asking questions, the process of delivering information directly from the teacher is dominant (Santosa, 2008).

The same results can also be seen in several previous studies showing that PBL can improve students' critical thinking skills. Like the research conducted by Jumaisyaroh et al. (2015) and Astriningtyas et al. (2018). Jumaisyaroh et al. (2015), in their research, explained that the increase in mathematical critical thinking skills of students who were given problem-based learning was higher than those who were given direct instruction.

Astriningtyas et al. (2018) show that using learning models can improve critical thinking skills and learning outcomes in solving story problems in math subjects. It can be proven by the increase in students' critical thinking skills from initial conditions (no critical) to quite critical at the end of cycle II.

Maximizing learning activities can be done with various efforts, one of which is by using learning media to deliver subject matter, as stated in Permendikbud Number 22 of 2016 concerning Standards for Primary and Secondary Education Processes. Learning media is expected to help the learning process run well. Learning media facilitates the learning process in various groups to stimulate students' interest in learning and create learning situations that students do not easily forget. Furthermore, in the learning process more effective and efficient to achieve maximum learning outcomes.

One of the media that can be used as learning media is visual media. Visual media are media that involve sensing. There are various types of visual media, including non-projected visual media. Using non-projected visual media is vital in learning because it can facilitate understanding and strengthen students' memory. Because in essence, non-projected visual media can translate abstract ideas or learn into more real ones, making it students faster and easier to understand the material (Saisabila et al., 2018). Through the use of non-projected visual media in the mathematics learning process, it is expected that students can understand a concept that was initially abstract to become concrete.

CONCLUSION

This research shows that Problem Based Learning (PBL) assisted by visual media affects the student's critical thinking skills at the 95% confidence level. All steps in the PBL learning process improve every indicator of critical thinking skills. This research can be a reference for teachers to apply PBL assisted by visual media in their classrooms to increase students' critical thinking skills. Furthermore, they can also apply this treatment in other materials, limited to visual media and audio-visual media-assisted PBL.

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