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THE EFFECT OF PROBLEM BASED LEARNING MODEL ON STUDENTS MATHEMATICAL CRITICAL THINKING ABILITY

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Abstract: This quasi-experimental study sought to assess the impact of the problem-based learning model on students' abilities in mathematical critical thinking. The population for this study consisted of all seventh-grade students at SMP Negeri 8 Bandar Lampung during the 2024/2025 academic year, totaling 231 students distributed across eight classes. The samples in this study were selected from two groups of 28 students and 27 students, chosen through cluster random sampling. The research design employed was a pretest-posttest group design. The data for this study were quantitative, collected from tests assessing students' mathematical critical thinking abilities. According to the results of hypothesis testing using the t-test, students who engaged in the problem-based learning model demonstrated a more substantial increase in their mathematical critical thinking skills than those who participated in the STAD-type cooperative learning model. This finding suggests that the problem-based learning approach significantly influences the development of students' mathematical critical thinking abilities.

Keywords: problem based learning; mathematical critical thinking

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Introduction

Education plays a vital role in enhancing the quality of human resources. High-quality education leads to the development of competent human resources. High-quality education can serve as a key solution to address existing challenges. One approach to enhance educational quality is by focusing on improving the education system itself (Susanto, 2014). An important aspect to focus on in improving education quality is the learning process, which involves both teachers and students. This is consistent with regulation of the government Law No. 4 of 2022 issued by the Republic of Indonesia regarding National Education Standards.

Mathematics serves as a subject that supports character development by enhancing students' soft skills. These soft skills in mathematics include understanding, reasoning, problem-solving, communication, making connections, and critical thinking abilities in mathematical contexts (Ratnawati., *et al*., 2020). Hasratuddin (2013) the goals of mathematics learning include enabling students to: 1) recognize patterns and properties, and manipulate mathematical concepts to formulate generalizations, proofs, and statements; 2) solve various problems, including developing models and interpreting the results; 3) communicate mathematical ideas and symbols; and 4) develop through

curiosity, focus, and a keen interest in mathematics, students develop an appreciation for its significance in daily life. Additionally, mathematics education seeks to cultivate and enhance students' mathematical skills. Because of the important role of mathematics, teachers must be able to make mathematics a subject that is favored by students and can help success in the learning process (Suriyani, 2017).

Mathematical critical thinking is an essential skill that students are required to possess. Tanjung & Nababan (2018) said that critical thinking is an active process of thinking and does not take information or ideas from others for granted, but is processed and thought deeply, asking questions related to the questions being thought about and finding information that is relevant to the problem being thought about. However, in reality, students in Indonesia have yet to demonstrate strong proficiency in mathematical critical thinking relatively low, this is evident from the findings of a survey carried out by PISA (The Programme for International Student Assessment) in 2022 showing that there was a 13-point decrease in scores in the aspect the mathematical abilities of Indonesian students remain low, as reflected by an average score of only 366 points. A similar issue concerning weak mathematical critical thinking skills is evident at SMPN 8 Bandar Lampung. The evidence to support the statement is the results of tests conducted to see.

Based on the above problems, a mathematics learning activity is needed that can improve students' mathematical critical thinking skills. Where learning must focus on solving problems while being able to develop students' abilities to students actively construct their own understanding. Problem-based learning is a form of open-ended education that serves as a context for developing problem-solving abilities, enhancing critical thinking skills, and creating new knowledge. This approach also incorporates real, unstructured problems. Problem-based learning makes innovative learning using problems related as an essential aspect of learning, it relates directly to students' real-life contexts (Anggraeni & Anugraheni, 2019). Problem-based learning is emphasizes active student engagement through real-world problem scenarios that require critical analysis and creative problem-solving. The problem-based learning model offers students opportunities to engage more actively in group discussions and collaboratively solve perceived problems. The stages of the problem-based learning approach consist of: 1) introducing students to the problem, 2) organizing learners into collaborative groups, 3) assisting in both solo and group explorations, 4) polishing and presenting the findings, and 5) reviewing and reflecting on the outcomes of the problem-solving effort. (Arifin et al., 2015).

According to Kurniawati & Ekayanti, (2020) critical thinking is an ability possessed by every individual, which can be trained, measured, and developed. Critical thinking is an organized process in solving problems involving mental activities that include the ability to formulate problems, provide arguments, perform deduction and induction, evaluate, and make decisions (Saputra, 2020).Critical thinking skills are abilities used in considering and making the right decisions by thinking logically, reflectively, and systematically (Hidayah, *et al*., 2017). Mathematical critical thinking ability is the ability of students to solve mathematical problems by gathering various kinds of information that they know and then making evaluative conclusions from the information they obtain (Taubah, 2018). In various educational systems, both formal and non-formal, critical thinking skills are considered important to teach, especially in the process of learning mathematics. Jayadipura (2014) said that one way that can improve critical thinking skills is by giving open ended problems.

Method

This study is a pseudo-experimental research consisting of independent variables and bound variables. Within this research, the independent variable, while the capacity for critical thinking in mathematics functions as the dependent variable. The data collection method employed in this

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research is through testing. A pretest-posttest control group design this study applies a design that includes both a control group and an experimental group, with pretest and posttest evaluations carried out (Sugiyono, 2013). The test used in this study assesses students' mathematical critical thinking skills through three questions related to the topic of Ratios/Comparisons.

This study involved 231 students who were distributed in 8 classes without a superior class. This study employed cluster random sampling as its sampling technique. Sugiyono (2019) said cluster random sampling is a random sampling technique based on clusters. This technique is used when the research subject is large and extensive. Before sailing, the two classes took a pretest to measure their initial abilities. After receiving the treatment, students take a posttest to measure the level of improvement in their learning outcomes. Subsequent steps include the analysis and interpretation of data collected through pretest and posttest assessments.

This research consists of three stages, namely preparation, implementation, and the end. First, the preparation stage, at this stage observations were made to the school to find out the characteristics of the population to be studied and determine the material. At this stage, the preparation of instruments and teaching devices was also carried out which were then consulted with partner teachers at the junior high school. The second stage is the implementation stage, at this stage the first meeting is given a pretest, then carry out learning by being given treatment, and at the final meeting a posttest is given. Class VII F as the experimental class was given treatment using a problem-based learning model and class VII H as the control class was given treatment using the STAD type cooperative learning model. The next stage is the final stage, at this stage the data from the pretest and posttest results are processed and analyzed.

Before the data was analyzed, prerequisite tests were carried out, namely normality test and homogeneity test. After the normality test was conducted, it was known that the sample came from a normally distributed population. After that, the homogeneity test is carried out, it is known that the sample comes from a population that has the same variance. Because the samples come from a normally distributed and homogeneous population, the hypothesis test uses the t test.

Results and Discussion

This research explores the effect of applying problem-based learning (PBL) models on enhancing students' abilities in mathematical critical thinking. To assess their initial abilities, pretest data were collected from students in both the PBL group and the STAD-type cooperative learning group. The results of this analysis, which are summarized in Table 1, show the students' baseline abilities prior to the intervention.

Table 1. Pretest score data

Class	Many students	Average	Standar deviation	Lowest score	Highest score
PBL	28	6,75	2,75	2	12
Kooperatif tipe STAD	27	6,14	3,40	0	11

Based on Table 1, that the average initial mathematical critical thinking ability of students in the PBL class is greater than that of students in the STAD cooperative class.

Following the implementation of the learning treatment, both classes were administered a posttest to assess the impact of the learning model on enhancing students' mathematical critical thinking abilities, as shown in Table 2.

Table 2. Posttest score data

Class	Many students	Average	Standar deviation	Lowest score	Highest score

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PBL	28	29,50	8,15	18	48
Koopratif tipe STAD	27	25,81	6,93	16	40

Based on Table 2, the students in the problem-based learning (PBL) class achieved a higher average final score in mathematical critical thinking compared to those in the STAD-type cooperative learning class. The mean posttest score achieved by students in the PBL class was 29.50, whereas for the STAD cooperative class, it was 25.81. Syamsidah & Hamidah (2018) suggest that this can be attributed to the use of real-life problems in the problem-based learning model, which effectively fosters the development of critical thinking skills. According to Syamsidah & Hamidah (2018), uggest that this is because the problem-based learning model uses real-life problems, which helps enhance critical thinking skills.

Problem-based learning provides students with a relevant and engaging learning environment that fosters the growth of critical thinking and improves their problem-solving skills. This indicates that the model is effective in advancing students' mathematical critical thinking abilities. The level of improvement was assessed by calculating the gain score, which is the difference between the posttest and pretest scores, divided by the difference between the highest achievable score and the pretest score. The results of the gain calculation are shown in Table 3.

Table 3. Gain score data

Class	**Many students**	**Average**	**Standar deviation**	**Lowest score**	**Highest score**
PBL	28	0,55	0,19	0,19	1,00
Kooperatif tipe STAD	27	0,46	0,16	0,18	0,80

Based on Table 3, students who apply problem-based learning show a greater improvement in mathematical critical thinking skills compared to those using other methods in the STAD-type cooperative class. Both the lowest and highest improvement scores in the PBL class were higher than those in the STAD-type cooperative class.

The results of the normality and homogeneity tests indicate that the data on the improvement of students' mathematical critical thinking skills in both groups follow a normal and homogeneous distribution. As a result, hypothesis testing is conducted using a parametric test, specifically a t-test, to compare the two means(Sudjana, 2005). The purpose of this test was to determine whether the average score of students who followed the problem-based learning model was higher than that of students who followed the STAD-type cooperative learning model. The value of t_{hitung} = 1,750 and t_{tabel} = 1.674 was obtained. Because of $t_{hitung} > t_{tabel}$, the average score of math-critical thinking skills gain of students who follow the problem-based learning model is higher than that of students who participate in learning with a STAD-type cooperative model.

A study by Sianturi et al. (2018) at SMPN 5 Sumbul concluded that students who learned through a problem-based learning approach achieved better outcomes in mathematical critical thinking than those taught with conventional methods. Similarly, research by Yuni *et al*. (2017) the use of the problem-based learning approach for seventh-grade students at SMP N 1 Candipuro has shown a positive impact on their mathematical critical thinking skills.

The problem-based learning approach is initiated by presenting contextual problems that are connected to real-life situations. Wiguna, *et al* (2021) It is stated that using contextual problems increases students' interest in learning and helps them grasp the material more easily. In this initial stage, students are guided to analyze the given problems in order to identify and formulate the core issues. The learning process involves authentic and engaging problems that encourage students to explore questions from multiple viewpoints. When students face these problems, they begin to realize

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that this can be viewed from various perspectives and to solve it requires the integration of information from various sciences.

The teacher facilitates group discussions among students to collaboratively solve the problems presented in the student worksheet (LKPD). At this stage, the teacher's role goes beyond simply dividing the class into groups. In this learning process, the teacher acts as a facilitator and coordinator, promoting active participation and meaningful interaction from every student. Because maximum interaction in a group is very decisive for success in problem solving. In this group, students actively express their opinions to each other about the initial idea of solving problems based on the knowledge they already have. Mareti & Hadiyanti (2021) said that in problem-based learning, students are invited to solve problems through discussion because it will make it easier for students to absorb the information received so that they can achieve completeness in learning.

Students solve problems from daily life presented in the LKPD through individual and group investigations. During group discussions, students are trained to present arguments and work together by sharing knowledge and understanding, thus facilitating the problem-solving process. Through investigation activities, students are expected to apply critical thinking skills in order to solve problems effectively. At the first meeting, some students still had difficulties when doing LKPD. There are some students who already understand the existing problems, but there are still some students who do not understand the instructions given. Trianto (2007) said that one of the important principles in education is that teachers do not only provide knowledge to students, teachers give opportunities to students to discover or apply their own ideas. Conducting activities through group discussions allows students to jointly find solutions to problems that arise in the first place.

Following the completion of the group discussion, one group is given the chance by the teacher to present their findings to their classmates. At this stage, teachers randomly select groups that are assigned to present the results of their discussions, as well as give opportunities to other groups to respond and help students who are experiencing difficulties. At the first meeting, students were still hesitant and lacked confidence in conveying the results of their work, but at the next meeting the students were very enthusiastic about conveying the results of their work. Oktavianto (2017) said that making and presenting works trains students to think critically, because students must convey ideas/ideas in groups so that students make a hard effort in thinking which directly improves students' skills in high-level thinking. This process trains students to be more confident and courageous in public speaking.

The evaluation stage is the stage where students think openly in solving problems so as to allow students to find strategies to solve problems (Turmuzi, *et al*. 2022). At this stage, the teacher helps students analyze and evaluate the problem-solving process they have worked on. Meanwhile, students rearrange the results of thought and activities that were exceeded at the problem-solving stage. Students are required to make a final conclusion from the results of the discussions that have been conducted. It is hoped that after making a conclusion, students will have a conceptual understanding of the problems that have been discussed. At the first meeting, students are not used to concluding the problems given.

Conclusion

Based on the research findings, the problem-based learning model has a positive impact on the mathematical critical thinking abilities of seventh-grade students at SMP Negeri 8 Bandar Lampung in the even semester of the 2024/2025 academic year. This influence is evidenced by a greater improvement in the mathematical critical thinking scores of students who engaged in problem-based learning compared in contrast to those who are taught using the STAD-type cooperative learning approach. Some suggestions that can be given are for teachers, especially teachers in mathematics who

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want to apply a problem-based learning model, should pay more attention to the contextual problems given. For other researchers, choose materials that match the criteria of the problem-based learning model in order to achieve the desired goals.The conclusions section answers to hypotheses, research objectives and research findings as well as suggestions related to further ideas from the research. Conclusions are presented in paragraphs.

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