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Implementation of Project-Based Learning on Students' Critical Thinking in Mathematics Learning in The Independent Curriculum

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Abstract

This research aims to determine the effect of project implementation-based Learning on critical-thinking students learning mathematics in the Merdeka curriculum. This research includes experimental research using the Quasi-Experimental Design technique. The research design uses a Nonequivalent Control Group Design. The population in this study was all class students XI-SAINKES SMAN 2 Pare Technique Merdeka curriculum, using the cluster random sampling technique, two classes of XI-SAINKES SMAN 2 Pare were obtained with a total of 35 students in each class. This research instrument uses a critical thinking test. Meanwhile, data analysis uses the Independent Sample t-test. From the analysis results, it can be concluded that implementing Project Based Learning influences critical thinking students in mathematics learning in the independent curriculum with a calculated t_{value} of 11.331 > 1.998 t_{table}. Where after the implementation of PjBL in class

INTRODUCTION

Learning mathematics in the independent curriculum encourages students to find out and build their knowledge with guidance from the teacher. Implementing independent learning creates higher quality and more advanced mathematics learning (Anggreini & Priyojadmiko, 2022). With this new curriculum, it is hoped that students will not only rely on memory in learning mathematics but will also be able to understand the origin of a rule and develop it to solve certain cases. In the Merdeka curriculum, project-based learning plans are prepared in stages, initially identifying problems using contextual questions or problems adapted to the school environment's characteristics (Malikah et al., 2022).

Mathematics is a science that has great potential to develop students' thinking skills, especially critical thinking (As'ari et al., 2017). Critical thinking is critical, not only in learning mathematics. Critical thinking is also very important for every aspect of life (Aizikovitsh-Udi & Cheng, 2015). Critical thinking and solving problems are necessary to obtain, manage, and utilize information in life, which continues to develop in society (Sutini, 2017). Using problem-solving skills requires critical thinking to determine each step towards a convincing solution.

Solving problems well requires critical thinking (Zetriuslita et al., 2016). Critical thinking is based on or formed by critical thinking abilities and critical thinking dispositions (Aizikovitsh-Udi et al., 2014). Critical thinking skills are developed with direct instruction. In contrast, critical thinking dispositions require experience in a learning environment that encourages students to ask questions about the material rather than just receiving it immediately. Suppose students often receive training in critical thinking. In that case, students will gain much experience and become accustomed to a learning environment that supports critical thinking so that they can form students' critical thinking dispositions.

Critical thinking consists of six components: interpretation, analysis, evaluation, inference, explanation, and self-regulation. In comparison, critical thinking consists of seven components: systematic, inquisitive, judicious, truth-seeking, confident in reasoning, open-minded, and analytical (Facione, 2016).

From the observations carried out in September 2023, researchers found that mathematics learning in class has not been able to determine other alternative solutions.

This is because, in the learning process, students tend to be passive and only accept explanations at face value. Students tend to be passive because teachers' learning methods are lectures and do not involve students. The teacher delivers the material, and the students sit and listen to what the teacher is talking about without making any effort to seek understanding of the information. Based on interviews with teachers, the mathematics abilities of class XI-SAINKES students at SMAN 2 Pare are relatively good, and students have no difficulty working on mathematics problems. However, they are not taught to communicate their mathematical ideas with presentations. They tend to immediately write down the final results or direct answers without a systematic method.

Apart from that, the initial ability test carried out in February 2024 showed that the results of students' skills in providing simple explanations were 61.15% or low category, students' skills in providing further explanations were 52.87% or low categories, students' skills in managing strategies and tactics is 54.89% or low category, and students' skills in concluding and evaluating or assessing are 32.76% and still in the low category. Based on the assessment of each aspect of students' critical thinking, it was found that the critical thinking abilities of class XI-SAINKES SMAN 2 Pare students were at a low level, with a percentage of 50.42%. To overcome this problem, implement PjBL (Project-Based Learning). PjBL is a learning model that supports students' critical thinking.

This learning model is perfect for developing students' thinking, decision-making, problem-solving, and self-management skills (Abidin, 2014). PjBL is an innovative learning model used as an alternative to developing students' skills in the 21st century (Prahani et al., 2020). During learning activities, PjBL provides students opportunities to gain knowledge, improve understanding, and master new skills (ChanLin, 2008). The benefit of using the PjBL learning model is that this model can accommodate students' learning interests (Umar & Ko, 2022). Another benefit is that freedom in planning learning, preparing projects to solve problems, and completing tasks collaboratively can increase students' cooperative attitudes and develop skills (Jalinus et al., 2020).

Based on the benefits above, what is developed in PjBL is that students learn problem-solving during project creation activities. Therefore, in the PjBL learning process, problems are the first step in exploring students' knowledge and experience. From these activities, students strive to find knowledge in investigative activities until they determine solutions in the form of products or tools to solve problems (Alafouzou et al., 2013).

METHOD

This research includes experimental research. According to Alsa (2004), experimental research aims to find the effect of treatment on behavior that arises as a result of treatment. The research technique used in this research is Quasi-Experimental Design. It is said to be a quasi-experimental design because controlling all relevant variables is impossible. In contrast, the design in this research is a Nonequivalent Control Group Design. This design is almost identical to the pretest–posttest control group design.

The population in this study consisted of all students of each class, with each class having 35 students. This research instrument uses a critical thinking test. To determine whether the instrument is appropriate before it is used to collect research data, the three instruments are tested on students who are not research samples, and then the results are tested for validity and reliability (Lestari & Andriani, 2019). Meanwhile, the data analysis used in this research is the Independent Sample t-test

RESULTS

Based on the test results of the critical thinking test instrument, the calculated r value for all question items was > 0.334 r table. This means that the critical thinking test instrument is said to be valid. Meanwhile, Cronbach's alpha value was 0.695 based on the reliability test results. According to Ghozali (2016), if Cronbach's alpha value is > 0.6, then an instrument is said to be reliable. Thus, it can be concluded that the critical thinking test instrument is worthy of being used as a research instrument.

Based on the results of the research that has been carried out, it can be seen that students' critical thinking before and after implementing the PjBL learning model is as follows:

Table 1. Students' Critical Thinking Before and After Implementing the PjBL Learning Model

Category	Before PjBL Implementation		After PjBL Implementation	
	F	%	F	%
Less Critical	0	0%	0	0%
Quite Critical	19	54%	0	0%
Critical	16	46%	6	17%
Very critical	0	0%	29	83%

Table One above shows how, before implementing PjBL in class XI-SAINKES SMAN 2, Pare, students thought critically; 54% of students were quite critical, and 46% were critical. Meanwhile, after implementing PjBL in class XI-SAINKES SMAN 2 Pare,

critical thinking increased; 17% of students were critical, and 83% were critical.

The results of the critical thinking data were then analyzed using the Independent Sample t-test. Before carrying out the Independent Sample t-test analysis, prerequisite analysis tests, namely normality and homogeneity, are carried out. The results are as follows:

Table 2. Normality Test Results

Test	*Asymp. Sig. (2-tailed)*	Level of significance	Conclusion
Pretest Experimental	0,200	0,05	Normally distributed
Posttest Experimental	0,079	0,05	Normally distributed
Pretest Control	0,200	0,05	Normally distributed
Posttest Control	0,200	0,05	Normally distributed

From the normality test results data in Table 2, it is known that Asymp. Sig. (2-tailed) data from the experimental and control classes are 0.200, 0.079, 0.200, and 0.20, respectively. According to Widiyanto (2013) data is said to be normally distributed if the Asymp value is used. Sig. (2-tailed) or P-value > α (0.05). Based on this opinion, it can be concluded that the sample data is normally distributed.

Table 3. Homogeneity Test Results

Tes	*Levene Statistic*	df1	df2	Sig.	Conclusion
Pretest	0,193	1	68	0,662	Homogenous
Posttest	0,414	1	68	0,522	Homogenous

From the calculation of the homogeneity test in Table 3, the significance results obtained in the pretest were 0.662 > 0.05. In the posttest, namely 0.522 > 0.05, the control and experimental groups were homogeneous because they had the same variance.

Before conducting research, it is best to carry out an equality test; this is done to determine whether the control and experimental groups have the same critical thinking abilities. The results of the equality test are as follows:

Table 4. Initial Ability Equality Test Results

Sig	t_{count}	Df	t_{table}	Test Decision
0,866	0,169	68	1,998	H_0 is accepted

Based On the results of the independent sample t-test in Table 3, it was found that the tcount was 0.169 < 1.998 tcount and a significance value of 0.866 > 0.05. This means that H_0 is accepted and H_a is rejected, so there is no difference between students' initial critical thinking abilities in the control and experimental groups or, in other words, students' initial critical thinking abilities in equal conditions.

After knowing that the population is normally distributed and has the same variance, the next step is to conduct a t-test, which will later be used to test the hypothesis of this research. The results of the independent sample t-test can be seen in Table 5.

Table 5. Hypothesis Results

Sig	T_{count}	Df	t_{table}	Test Decision
0,000	11,331	68	1,998	H_a accepted

DISCUSSION

Based on the t-test results using the independent sample t-test in Table 5, the tcount is 11.331 > 1.998 t table, and the significance value is 0.000 < 0.05, so H_0 is rejected, and H_a is accepted. Thus, it can be concluded that project-based Learning affects students' critical thinking when learning mathematics in an independent curriculum.

PjBL is a learning model that supports students' critical thinking. This is supported by Abidin (2014), who stated that the PjBL learning model is very good at developing students' thinking, decision-making, problem-solving, and self-management skills. PjBL is an innovative learning model used as an alternative to developing students' skills in the 21st century (Prahani et al., 2020). During learning activities, PjBL provides students opportunities to gain knowledge, improve understanding, and master new skills (ChanLin, 2008).

CONCLUSION

From the results of the analysis, it can be concluded that project-based learning affects students' critical thinking when learning mathematics in an independent curriculum. Where after the implementation of PjBL in class.

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