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The effect of inquiry learning models on students' acquisition and improvement of mathematical critical thinking skills in trigonometric comparison material

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ABSTRACT

The study aimed to analyze the effect of the inquiry learning model on students' acquisition and improvement of mathematical critical thinking skills. The method used was a quasi-experiment with a pretest-posttest control group design, involving 68 students from X State High School 1 Pagai Utara Selatan (34 students in the experimental class and 34 students in the control class). Data were collected through a mathematical critical thinking ability test on trigonometric comparison material, then analyzed using a t-test with SPSS. The results showed p = 0.006, indicating a significant difference between the effects of the inquiry-based learning model and conventional learning on students' mathematical critical thinking skills. Furthermore, the n-gain analysis showed p = 0.004, indicating that both the inquiry-based learning model and the conventional learning model influenced improvements in students' mathematical critical thinking skills. These findings demonstrate that the inquiry-based learning model is more effective in developing mathematical critical thinking. This study recommends the implementation of inquiry as an alternative learning strategy, particularly for mathematics topics requiring in-depth analysis.

1. Introduction

Critical thinking skills are one of the most important aspects. Critical thinking skills are intellectual abilities that every individual must possess and can be developed through the learning process. Mathematical critical thinking skills are essential competencies for students in facing the challenges of the 21st century, especially for analyzing problems, evaluating arguments, and formulating logic-based solutions [1]. In the context of mathematics learning, mathematical critical thinking is the ability to think in order to solve mathematical problems using scientific methods. Several experts have defined critical thinking as follows: (1) According to Beyer in systematic thinking ability [2], critical thinking is a disciplined way of thinking that a person uses to evaluate the validity of something (statements, ideas, arguments, and research) (2) According to Fisher in his statement [3], critical thinking is explaining what one thinks. (3) Meanwhile, according to Ennis in his statement [2], critical thinking is a process that involves expressing one's goals with clear reasons for one's beliefs and actions. Based on the definition of critical thinking skills in the previous paragraph, it can be concluded that critical thinking is the ability to analyze, debate, and make decisions based on facts, logical arguments, and available evidence. In critical thinking, a person is expected to be able to examine assumptions, identify patterns, detect bias, and construct coherent and logically based arguments. The critical thinking process involves reflective and independent thinking, where individuals try to understand, rotate, and construct solutions to a problem in a systematic and precise manner.

The importance of critical thinking skills lies in their ability to improve decision-making. Through critical thinking, individuals can weigh various alternatives, identify potential risks and benefits, and thus make more informed decisions. Critical thinking also leads to effective problem solving, as the ability to analyze problems in depth and find creative solutions is at the core of critical thinking. Recent research shows that this skill is still low among students, largely due to learning models that do not sufficiently encourage independence and reasoning [4]. For example, a study by As'ari et al. revealed that 65% of students had difficulty completing mathematics questions based on higher-order thinking skills (HOTS), which require critical analysis [5]. Furthermore, critical thinking skills are important for effective communication. Critical thinking skills help us to construct strong arguments or opinions, see things from different perspectives, and communicate with others. Based on research Zahwa Amelia in his research, mathematical critical thinking skills are essential when students want to convey their ideas or thoughts or express their concepts to solve a mathematical problem [6]. Then, from the seminar Sulistianti, Students' critical thinking skills in mathematics learning are essential for understanding and solving mathematical problems or questions that require reasoning, analysis, evaluation, and interpretation [7]. This is also in line with research findings Fitriyah et,al states that one of the skills that today's children must have is critical thinking [8]. Critical thinking skills are an important component that students must have, especially in the process of learning mathematics [9].

In reality, students' mathematical critical thinking skills are still not optimal, as stated by M.S. Tanjung, which states that the implementation of mathematics learning in schools has not fully trained students' critical thinking skills [10]. One of the main causes of low critical thinking skills is the dominance of conventional learning that focuses on memorization and routine procedures [11]. Teachers often do not give students space to explore concepts through investigation or contextual problem solving [12]. Many efforts can be made to optimize this, including choosing a learning model that is believed to improve students' mathematical critical thinking skills, namely the inquiry model. The advantage of the inquiry learning model is that students do not receive concepts/learning materials directly, but each student is required to be active in asking and answering questions in order to stimulate their curiosity and enable them to think critically in mathematics [13]. Research by T. Evans [14] proves that inquiry-based learning significantly improves students' critical thinking skills because it emphasizes the process of questioning, hypothesizing, and verification. According to Abidin in the inquiry learning model is a learning model developed so that students discover and use various sources of information and ideas to improve their understanding of specific problems, topics, and issues [15]. According to Anggareni et al., the Inquiry Learning Model is a design of activities that encourages all students' abilities in learning activities to search for and analyze critically, analytically, logically, and systematically, so that students are confident in formulating their own discoveries [16]. The effectiveness of the inquiry model still needs to be studied in greater depth, especially when compared to other models such as problem-based learning (PBL), which is also considered effective [17].

Controlling the effectiveness of inquiry learning in order to optimize students' critical mathematical thinking skills needs to be controlled by another model. I am interested in taking the problem-based learning model as the control class. I took the problem-based learning model because the problem-based learning model is a learning model that applies real problems or everyday problems as a context to train students in developing critical thinking attitudes, problem-solving skills, and gaining knowledge according to Dcuh in [18]. Problem problem-based learning model researcher used as a comparison for the inquiry-based learning. This study aims to analyze the effect of the inquiry learning model on improving students' mathematical critical thinking skills, with PBL as a control. This study is expected to provide theoretical contributions in identifying the most optimal learning model for critical thinking development, as well as practical contributions for teachers in designing reasoning-based mathematics learning. The research results can serve as a reference for curriculum developers to integrate the inquiry approach into mathematics materials, particularly in Indonesia, which still faces the challenge of low mathematical literacy [19].

2. Method

2.1 Type of Research

This study uses a quantitative approach with a quasi-experimental method and a nonequivalent control group pretest-posttest design [20]. This design was chosen because researchers were unable to fully randomize due to limitations in class grouping at the school [21]. The design is depicted as in Table 1.

Table 1. Nonequivalent control group pretest-posttest design

Group A:	O_1	X	O_2
Group B:	O_1		O_2

The research began with initial observation (O_1) of students' mathematical critical thinking skills to obtain a baseline of their abilities before the implementation of the treatment. After this preliminary stage, the intervention was carried out using inquiry-based learning (X), which emphasizes students' active involvement in exploring, questioning, and constructing knowledge through problem-solving activities. Following the implementation of this learning model, a final observation (O_2) was conducted to measure any improvements or changes in students' mathematical critical thinking skills. This sequence starting with initial observation, followed by inquiry-based learning, and ending with final observation was designed to clearly identify the effectiveness of the learning model in enhancing students' mathematical critical thinking abilities.

2.2 Sample and Population

The population in this study was the scores and improvement in critical thinking skills of 10th-grade students in Phase E at State High School 1, Pagai Utara Selatan, Mentawai Islands, West Sumatra Province. Sampling in this study used purposive sampling based on the following criteria: (1) classes with equivalent academic abilities, (2) teachers with similar experience and qualifications. The limitations of purposive sampling are acknowledged, but controlled by the homogeneity of the pretest [22].

2.3 Research Variabel

Independent variable: Learning model (inquiry vs. conventional). Dependent variable: Mathematical critical thinking skills (measured through objective tests).

2.4 Instruments and Data Validity

The instrument used was a mathematical critical thinking test (pre-test and post-test) based on Facione's indicators. An expert validation questionnaire (2 mathematics education experts) was used to ensure content validity (Aiken's V > 0.75). Reliability was tested using Cronbach's Alpha (α ≥0.70) through a pilot study.

2.5 Data Collection Procedure

A pretest was conducted before the treatment for both groups. The experimental class used inquiry-based learning (orientation, exploration, and analysis phases). The control class used conventional learning (PBL learning model). A posttest was conducted after three meetings.

2.6 Data Analysis

The prerequisite tests are normality and homogeneity. For hypothesis testing, use the t-test.

2.7 Validity

Construct validity is Confirmatory Factor Analysis (CFA) to test the structure of the instrument.

3. Results and Discussion

3.1 Results

In this study, the results included pretest, posttest, and gain scores of students' mathematical critical thinking skills using both the inquiry learning model and the conventional learning model. The collected data provided a comprehensive overview of students' progress before and after learning interventions. To ensure accurate interpretation, the data were systematically analyzed using SPSS software, which allowed detailed statistical testing and verification. This analysis was crucial for answering all research questions and for drawing valid conclusions about the effectiveness of the applied learning models. So, all data analysis in this research is based on the primary data in Table 2.

Table 2. Pretest, Posttest, and Gain Scores of Students' Mathematical Critical Thinking Skills Learning with the *Inquiry Learning Model* and the Conventional Learning Model

Inquiry Learning Model				**Conventional Learning Model**			
Student	***Pretest Score***	***Posttest Score***	***N-Gain (g)***	***Student***	***Pretest Score***	***Posttest Score***	***N-Gain (g)***
S1	8.33	91.67	0.91	S1	10.00	83.33	0.81
S2	1.67	90.00	0.90	S2	0.00	68.33	0.68
S3	8.33	95.00	0.95	S3	6.67	83.33	0.82
S4	13.33	98.33	0.98	S4	11.67	73.33	0.70
S5	13.33	88.33	0.87	S5	0.00	73.33	0.73
S6	10.00	100.00	1.00	S6	0.00	95.00	0.95
S7	11.67	98.33	0.98	S7	6.67	73.33	0.71
S8	8.33	81.67	0.80	S8	6.67	76.67	0.75
S9	8.33	86.67	0.85	S9	11.67	73.33	0.70
S10	6.67	91.67	0.91	S10	0.00	73.33	0.73
S11	0.00	76.67	0.77	S11	8.33	95.00	0.95
S12	3.33	88.33	0.88	S12	11.67	100.00	1.00
S13	1.67	86.67	0.86	S13	1.67	81.67	0.81
S14	5.00	83.33	0.82	S14	13.33	95.00	0.94
S15	0.00	100.00	1.00	S15	6.67	68.33	0.66
S16	13.33	100.00	1.00	S16	5.00	76.67	0.75
S17	0.00	80.00	0.80	S17	13.33	100.00	1.00
S18	1.67	76.67	0.76	S18	1.67	76.67	0.76
S19	6.67	86.67	0.86	S19	8.33	76.67	0.75
S20	5.00	100.00	1.00	S20	1.67	81.67	0.81
S21	5.00	90.00	0.89	S21	3.33	95.00	0.95
S22	6.67	90.00	0.89	S22	6.67	90.00	0.89
S23	6.67	100.00	1.00	S23	8.33	81.67	0.80
S24	5.00	81.67	0.81	S24	5.00	90.00	0.89
S25	6.67	75.00	0.73	S25	5.00	90.00	0.89
S26	0.00	85.00	0.85	S26	10.00	88.33	0.87
S27	0.00	86.67	0.87	S27	13.33	95.00	0.94
S28	10.00	91.67	0.91	S28	5.00	81.67	0.81
S29	10.00	86.67	0.85	S29	3.33	68.33	0.67
S30	6.67	95.00	0.95	S30	6.67	81.67	0.80
S31	3.33	95.00	0.95	S31	6.67	90.00	0.89
S32	6.67	81.67	0.80	S32	1.67	81.67	0.81
S33	5.00	95.00	0.95	S33	1.67	90.00	0.90
S34	11.67	100.00	1.00	S34	8.33	100.00	1.00

The maximum score in this study was set at 100 as the highest benchmark for measuring students' mathematical critical thinking ability. The description of the posttest data values with the inquiry learning model is presented in Table 3. Based on the analysis, the mean score of students reached 89.80 with a standard error of 1.28, indicating that the overall performance of students was high. The 95% confidence interval (87.18–92.42) shows the true mean of students' scores lies within this range, confirming reliability. The trimmed mean of 90.02 and median of 90.00 indicate most students consistently scored around 90. With a variance of 56.53 and standard deviation of 7.51, score dispersion was moderate. Scores ranged from 75.00 to 100.00, with a range of 25.00 and interquartile range of 11.25. Skewness −0.204 suggests near symmetry, while kurtosis −0.891 reflects a flatter distribution.

Table 3. Description of Posttest Data Values of Students' Mathematical Thinking Ability with the Inquiry Learning Model

Description			*Statistics*	*Std. Error*
Posttest Model Inquiry Value	Mean		89.8039	1.28939
	95% Confidence Interval for Mean	Lower Bound	87.1806	
		Upper Bound	92.4272	
	5% Trimmed Mean		90.0218	
	Median		90,0000	
	Variance		56.526	
	Std. Deviation		7.51838	
	Minimum		75.00	
	Maximum		100.00	
	Range		25.00	
	Interquartile Range		11.25	
	Skewness		-.204	.403
	Kurtosis		-.891	.788

From the output above, it was obtained that the average achievement of Critical Thinking Skills of students who learn using the inquiry learning model is 89.80. The standard deviation is 7.52, and the data is distributed negatively skewed. The following is a description of the post-test data values of students' mathematical thinking abilities with the conventional learning model in Table 4.

Table 4. Description of Posttest Data Values of Students' Mathematical Thinking Ability with Conventional Learning Models

Description			*Statistics*	*Std. Error*
Posttest_Conventional Model	Mean		83.7745	1.66861
	95% Confidence Interval for Mean	Lower Bound	80.3797	
		Upper Bound	87.1693	
	5% Trimmed Mean		83.7309	
	Median		81.6667	
	Variance		94,665	
	Std. Deviation		9.72958	
	Minimum		68.33	
	Maximum		100.00	
	Range		31.67	
	Interquartile Range		15.42	
	Skewness		.103	.403
	Kurtosis		-1.121	.788

From the output above, it is obtained that the average achievement of Critical Thinking Skills of students who learn with conventional learning models is 83.77. The standard deviation is 9.72, and the data is distributed positively skewed. Then this has an influence on inquiry learning towards the acquisition of critical mathematical thinking skills in students which can be explained in Table 5.

Table 5. The effect of inquiry learning on students' acquisition of critical mathematical thinking skills

Paired Samples Test										
		Paired Differences					*T*	*df*	*Significance*	
		Mean	*Std. Deviation*	*Std. Error Mean*	*95% Confidence Interval of the Difference*				*One-Sided p*	*Two-Sided p*
					Lower	*Upper*				
Pair 1	Pretest_Inquiry_Score - Posttest_Inquiry_Score	-83.62794	6.84625	1.17412	-86.01671	-81.23917	-71.226	33	<.001	<.001

From the Paired Samples Test, it turns out that the Two-Sided p value <0.001, and this value is smaller than 0.05 (α), so H_0 It is rejected and H_1 accepted, which means that the hypothesis stating that the Inquiry Learning Model has a significant effect on the acquisition of Students' Mathematical Critical Thinking Skills is accepted. It can also be explained how conventional learning influences students' acquisition of critical mathematical thinking skills in Table 6.

Table 6. The influence of conventional learning on students' acquisition of critical mathematical thinking skills

Paired Samples Test										
		Paired Differences							*Significance*	
		Mean	*Std. Deviation*	*Std. Error Mean*	*95% Confidence Interval of the Difference*		*t*	*df*	*One-Sided p*	*Two-Sided p*
					Lower	*Upper*				
Pair 1	Conventional_Pret //est_Value - Conventional_Posttest_Value	-77.59735	9.06714	1.55500	-80.76103	-74.43368	-49,902	33	<.001	<.001

From the Paired Samples Test, it turns out that the Two-Sided p value <0.001, and this value is smaller than 0.05 (α), so H_0 It is rejected and H_1 accepted, which means that the hypothesis stating that the conventional learning model has a significant effect on the acquisition of Students' Mathematical Critical Thinking Skills is accepted. When combined, the results of the influence of the inquiry learning model and conventional learning on students' acquisition of critical mathematical thinking skills can be obtained, which can be seen in Table 7.

Table 7. The influence of inquiry learning models and conventional learning on students' acquisition of critical mathematical thinking skills

Independent Samples Test											
		Levene's Test for Equality of Variances		*t-test for Equality of Means*							
		F	*Sig.*	*T*	*Df*	*Significance*		*Mean Difference*	*Std. Error Difference*	*95% Confidence Interval of the Difference*	
						One-Sided p	*Two-Sided p*			*Lower*	*Upper*
Posttest_value	Equal variances assumed	3,543	.064	2,860	66	.003	.006	6.03029	2.10872	1.82010	10.24049
	Equal variances not assumed.			2,860	62,047	.003	.006	6.03029	2.10872	1.81508	10.24550

The results of the Independent Samples Test showed that the two-tailed significance value (p) obtained was 0.006. This value is much smaller than the predetermined significance level of 0.05 (α). Based on the rules of hypothesis testing, if the significance value is less than α, then the null hypothesis (H_0) must be rejected and the alternative hypothesis (H_1) is accepted. In this study, the rejection of H_0 means that there is enough statistical evidence to conclude that the two learning models—inquiry learning and conventional learning—do not have the same effect on students' mathematical critical thinking abilities. On the contrary, the acceptance of H_1 supports the proposed hypothesis that there is indeed a significant difference between the two models. More specifically, students who were taught using the inquiry learning model showed higher achievement and stronger critical thinking skills compared to those taught with the conventional learning model. This finding indicates that the inquiry-based approach, which emphasizes active student involvement in exploring, questioning, and solving problems, provides greater effectiveness in developing critical mathematical thinking. Thus, the results reinforce the importance of implementing innovative learning strategies such as inquiry learning to improve students' higher-order thinking skills. Then the description of the N-Gain data on students' mathematical thinking abilities with the inquiry learning model can be seen in Table 8.

Table 8. Description of N-Gain Data on Students' Mathematical Thinking Ability with the Inquiry Learning Model

Description				
			Statistics	***Std. Error***
N_Gain_Inquiry	Mean		.8926	.01349
	95% Confidence Interval for Mean	Lower Bound	.8652	
		Upper Bound	.9201	
	5% Trimmed Mean		.8950	
	Median		.8900	
	Variance		.006	
	Std. Deviation		.07867	
	Minimum		.73	
	Maximum		1.00	
	Range		.27	
	Interquartile Range		.11	
	Skewness		-.173	.403
	Kurtosis		-.921	.788

From the output above, it is obtained that the average achievement of Critical Thinking Skills of students who learn with the inquiry learning model is 0.89. The standard deviation is 0.79, and the data is distributed negatively skewed (data is gathered at high scores). The results of the N-Gain data description of students' mathematical thinking abilities using the conventional model can be seen in Table 9.

Table 9. Description of N-Gain Data on Students' Mathematical Thinking Ability with the Conventional Model

Description				
			Statistics	***Std. Error***
N_Gain_Conventional Learning	Mean		.8271	.01761
	95% Confidence Interval for Mean	Lower Bound	.7912	
		Upper Bound	.8629	
	5% Trimmed Mean		.8265	
	Median		.8100	
	Variance		.011	
	Std. Deviation		.10268	
	Minimum		.66	
	Maximum		1.00	
	Range		.34	
	Interquartile Range		.17	
	Skewness		.132	.403
	Kurtosis		-1.116	.788

From the output above, it is obtained that the average achievement of Critical Thinking Skills of students who learn with conventional learning models is 0.83. The standard deviation is 0.1, and the data is distributed positively skewed (data is gathered at low scores). Then in Table 10, the influence of both on students' thinking abilities can be explained. The results of the Independent Samples Test revealed that the two-tailed significance value (p) obtained was 0.004. This value is clearly smaller than the predetermined significance level of 0.05 (α), which becomes the critical threshold for decision-making in hypothesis testing. Since the p-value is less than α, the correct statistical decision is to reject the null hypothesis (H_0) and accept the alternative hypothesis (H_1). In the context of this research, the rejection of H_0 indicates that there is sufficient evidence to state that the inquiry learning model and the conventional learning model do not produce the same effect on students' mathematical critical thinking abilities. The acceptance of H_1 confirms that there is a significant difference between the two learning approaches in terms of their impact on improving these higher-order skills. More specifically, the inquiry learning model provides a stronger influence on enhancing students' critical mathematical thinking compared to the conventional model. This is due to the fact that inquiry learning encourages students to explore, analyze, and solve problems actively, which trains them to think more critically and systematically. Thus, the statistical results not only support the research hypothesis but also highlight the practical importance of adopting inquiry-based strategies in mathematics classrooms to foster better learning outcomes.

Table 10. The influence of inquiry learning models and conventional learning on improving students' critical mathematical thinking skills

Independent Samples Test											
		Levene's Test for Equality of Variances		*t-test for Equality of Means*							
		F	*Sig.*	*T*	*df*	*Significance*		*Mean Difference*	*Std. Error Difference*	*95% Confidence Interval of the Difference*	
						One-Sided p	*Two-Sided p*			*Lower*	*Upper*
Score_G_KBK	Equal variances assumed	3.618	.062	2,957	66	.002	.004	.06559	.02218	.02130	.10988
	Equal variances not assumed.			2,957	61,817	.002	.004	.06559	.02218	.02124	.10994

3.2. Discussion

3.2.1 Overview of Students' Acquisition of Critical Mathematical Thinking Skills in Inquiry and Conventional Models

Descriptive analysis shows that the average posttest score of the Inquiry group (89.80) is higher than that of the conventional group (83.77). The standard deviation in the Inquiry group (7.52 vs. 9.73) indicates higher homogeneity of results, supported by a negative distribution (-0.204), which signifies a concentration of high scores. Conversely, the positive distribution (0.103) in the conventional group reflects a tendency toward lower scores. These findings align with previous research [23], which states that the inquiry learning model can improve students' mathematical critical thinking skills when used in learning activities. Meanwhile, Pramestika, et al states that the conventional model is effective [24], where by variations in students' mathematical critical thinking abilities in solving problems result in more diverse scores. However, it is important to consider contextual factors such as student background and teacher support, which also influence the distribution of scores [25].

3.2.2 The Influence of Inquiry and Conventional Models on Critical Thinking Skills

The results of the paired sample t-test showed a significant effect for both models ($p < 0.001$), but with a small effect size (Cohen's $d < 0.2$). This means that although statistically significant, the practical impact is limited. The inquiry-based learning model is more effective in the context of problem-based learning, while the conventional learning model remains relevant for material that requires memorization [26]. Implicitly, the selection of models must be tailored to learning objectives and student characteristics.

3.2.3 Differences in the Influence of Inquiry and Conventional Models

The independent sample t-test showed a significant difference ($p = 0.006$) with a moderate effect size (Cohen's $d = 0.694$). The advantages of inquiry can be explained through its systematic stages (orientation, exploration, and confirmation) that facilitate critical reasoning. However, its effectiveness depends on the teacher's readiness to manage discussions and learning resources. A study by Furtak, et al, noted that the implementation of less structured inquiry can actually reduce this advantage [27].

3.2.4 Improving Students' Mathematical Critical Thinking Skills (N-Gain)

The average N-gain of the inquiry group (0.89) was higher than that of the conventional group (0.83), indicating a greater improvement. This is in line with research Rahmi, *et al* [28]. The application of the inquiry-based learning model has a positive effect on students' critical thinking skills because it involves stages of discovery and analysis.

3.2.5 Difference in Gain (N-Gain) between Inquiry and Conventional

The significant difference in N-Gain (p = 0.004) with a moderate effect size (Cohen's d = 0.717) reinforces previous findings. The data analysis and conclusion phases of inquiry specifically train analytical skills. This occurs because the systematic learning structure in inquiry, namely the orientation, exploration, and confirmation phases, helps students understand concepts gradually [29]. In addition, inquiry-based learning encourages students to analyze data and draw conclusions more often, which is also in line with research Firdaus, et al, where students do more data analysis and draw conclusions, thereby training their mathematical critical thinking skills [30]. However, this study has limitations such as not controlling for teacher effects and student motivation variables that can moderate the results.

4. Conclusion

Based on the research results and discussion, the following conclusions were obtained: (1) The Inquiry Learning Model is significantly more effective in improving students' mathematical critical thinking skills than the conventional model (Problem-Based Learning), with an average N-Gain of 0.89 (high category) vs. 0.83 (moderate category). The effect size of this difference is classified as moderate (Cohen's d = 0.717), indicating that inquiry is not only statistically significant but also practically meaningful; (2) The mechanism behind inquiry's superiority lies in its systematic structure (orientation, exploration, and confirmation), which facilitates critical reasoning through data analysis, hypothesis, and verification activities. This is in line with Facione's (1990) findings that critical thinking indicators such as interpretation, analysis, and inference are better developed in inquiry-based learning; (3) Theoretical implications: This study reinforces the constructivist theoretical framework by showing that learning that actively involves students in concept discovery (such as inquiry) is more effective for developing higher-order thinking skills; (4) Practical implications: (1) Teachers are advised to adopt the inquiry model for mathematics material that requires in-depth analysis, ensuring the readiness of scaffolding and learning resources; (2) Curriculum developers need to integrate inquiry phases into learning design, especially in the Indonesian context, which still faces challenges in mathematics literacy; (5) Limitations and suggestions: (1) This study did not control for external variables such as student motivation and teacher teaching style; (2) Further studies could compare inquiry with other models (e.g., discovery learning) or test the moderation of student psychological factors; (3) Further exploration is needed on the implementation of inquiry in schools with heterogeneous academic abilities to ensure the generalizability of the findings.

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