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THE INFLUENCE OF THE INQUIRY BASED LEARNING MODEL IN STUDENTS MATHEMATICS LEARNING: A META-ANALYSIS

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Abstract

The purpose of this study is to determine the reason for inquiry learning model for students' mathematics learning. This study is a meta-analysis study. The research data comes from 17 national and international journals published from 2015-2023. Data analysis in this study with the JSAP application. The inclusion criteria in this study are 1) research comes from journals or proceedings indexed by Scopus and SINTA; 2) The study has two experimental classes with inquiry-based learning models and conventional learning control classes; 3) journals or proceedings obtained from Google Scholar, AIP Proceedings, IOP Proceedings, Wiley, ERIC Journa and ScienceDirect. The results of the study concluded that the summary effect size or mean effect size value was 0.833 height criteria and values (Z = 9,061; p < 0.001). This finding explains that the inquiry-based learning model has a positive effect on students' mathematics learning compared to conventional models.

Keywords: Inquiry based learning; Size effect; Mathematics Learning, Meta-analysis

INTRODUCTION

Mathematics learning is a learning that requires students to think critically in learning (Muhammad et al., 2023; Hofer et al., 2023; Wardat, 2023). In addition, students' mathematics learning must have problem-solving skills in learning (Khatimah &, 2019; Bishara, 2016). Metamatics learning plays an important role in the development of technology and education (Lucky &; Julyanti, 2023). Verawati et al., (2022) mathematics

learning can develop students' logical and critical thinking skills. In mathematics learning, students must be able to understand concepts well (Dadang et al., 2022).

But in reality, mathematics learning at school is difficult for students to understand so that the learning process is menoton (Sugianto et al., 2022; Darmayanti &; Sugianto, 2022). The results of the *2015 Trends in International Mathematics and Science Study* (TIMSS) survey showed that students' ability to think critically in mathematics was relatively low, only obtaining a score of 391, far from the international average score of 500 (Zulyusri et al., 2023; Oktarina et al., 2021; Suharyat et al., 2022; Rahman et al., 2023; Sofianora et al., 2023). Low student mathematics learning is caused by students' creative thinking and problem-solving skills are still low so that students are less active in learning (Calder et al., 2022; Salsabila &; Princess, 2023). In addition, the teacher-centered learning process makes it difficult for students to understand the subject matter (Elfira et al., 2023; Zulyusri et al., 2022; Suharyat et al., 2022; Utomo et al., 2023; Suryono et al., 2023). So, there needs to be a learning model that can increase students' understanding of concepts in learning mathematics.

Inquiry-based learning is a learning model that can improve student learning outcomes in mathematics learning (Siregar &; Rangkuti, 2023). Inquiry-based learning is a learning model that involves students to investigate a problem in learning (Fadilah et al., 2023; Öztürk et al., 2022; Kang, 2022; Lampros, 2022; Archer et al., 2021). *Inquiry-based learning* can improve students' critical thinking and mathematical problem solving skills (Minarti et al., 2022; Ridwan, 2022). The inquiry-based learning model helps students learn more actively and creatively so that they can understand the subject matter more easily (Houghton et al., 2022).

Research (Paramita &; Rini, 2023; Lampros, 2022; Georgiou et al., 2023) That the *inquiry-based* learning model can encourage understanding of concepts and the ability to think critically in learning. In addition, research (Sreejun &; Chatwattana, 2023; Sonsun et al., 2023; Manishimwe &; Shivoga, 2022) Inquiry-based learning increases motivation, learning outcomes and science process skills of students carrying out teaching and learning activities. The gap in this research, many studies on inquiry-based learning did not find meta-analysis of *inquiry-based* learning in mathematics learning. Therefore, based on these problems, this study aims to determine the influence of *inquiry* learning models on students' mathematics learning.

RESEARCH METHOD

This research is a type of meta-analysis research. Meta-analysis is a type of research that collects and analyzes previous research quantitatively with statistics (Suparman et al., 2021; Santosa et al., 2021; Supriyadi et al., 2023; Nurtamam et al., 2023;. Karim et al.,, 2023; Chamdani et al., 2022). This meta-analysis research aims to determine the influence of inquiry-based learning in mathematics learning. . The research data comes from 17 national and international journals published from 2015-2023. Data

analysis in this study with the JSAP application. The inclusion criteria in this study are 1) research comes from journals or proceedings indexed by Scopus and SINTA; 2) The study has two experimental classes with inquiry-based learning models and conventional learning control classes; 3) journals or proceedings obtained from Google Scholar, AIP Proceedings, IOP Proceedings, Wiley, ERIC Journa and ScienceDirect. Data analysis techniques are quantitative analysis by calculating the effect size value of each study, conducting heterogeneity tests, determining estimation models, analyzing publication bias, calculating p-value to test research hypotheses with the help of the JSAP application.

Borenstein & Hedges (2009) meta-analysis research has steps consisting of determining inclusion criteria, literature search, data coding, evaluating research quality, data analysis and interpretation. The criteria for effect size in this study can be seen in Table 1.

Table 1. Effect *Size Criteria*

Effect Size	Criterion
0.00 ≤ ES ≤ 0.20	Ignored
0.20 ≤ ES ≤ 0.50	Low
0.50 ≤ ES ≤ 0.80	Medium
0.80 ≤ ES ≤ 1.30	High
ES ≥ 1.30	Very High

Source: Cohen's in (Aisyah &; udayana, 2022; Suharyat et al., 2023; Razak et al., 2021)

RESULT AND DISCUSSION

From searching 224 studies through the Google Scholar database, AIP Proceedings, IOP Proceedings, Wiley, ERIC Journa and ScienceDirect regarding inquiry-based learning models in mathematics learning, 10 journals were obtained that met the inclusion criteria. Research that has met the inclusion criteria is calculated effect size value which can be seen in table 2.

Table 2. *Effect Size* 11 Research Based on Inclusion Criteria

Journal Code	Year	Effect Size	Criterion
P1	2023	1.35	Very High
P2	2023	0.88	High
P3	2022	0.71	Medium
P4	2020	0.95	High
P5	2020	1.16	High
P6	2020	0.62	Medium
P6	2023	1.08	High

P8	2022	0.83	High
P9	2021	0.77	Medium
P10	2022	0.62	Medium

Based on Table 2. Explaining from the analysis of 10 studies, four studies obtained *effect size* values ranging from 0.62-0.77 medium criteria and five studies having effect sizes ranging from 0.83-1.35 very high criteria. Next, calculate the summary effect size or mean effect size of the entire study. The results of the calculation of *summary* effect size or mean effect *size* using the *random effect model* can be seen in Table 3.

Table 3. *Summary* Effect or *Mean Effect Size*

	Q	**Df**	**P**
Omnibus test of Coefficients Model	57.019	1	< 0.001
Test of Residual Heterogeneity	162.780	9	< 0.001

Table 3. shows the value of Q= 162.780 is greater than 57,019 with a confidence level of 95%. Furthermore, the value (p < 0.001) means that the distribution of effect size in this study is heterogeneously distributed. Therefore, *the random effect model* is more effectively used to analyze 1:0 of the analyzed studies. Next, calculate the publication bias of the 10 studies that have been analyzed. Calculation of publication bias in this study with *funnel plot* and *Roshental Fail Safe* (FSN) (Taşdemir, 2022); Tamur et al., 2020). The results of the calculation of publication bias with *funnel flot* can be seen in figure 1.

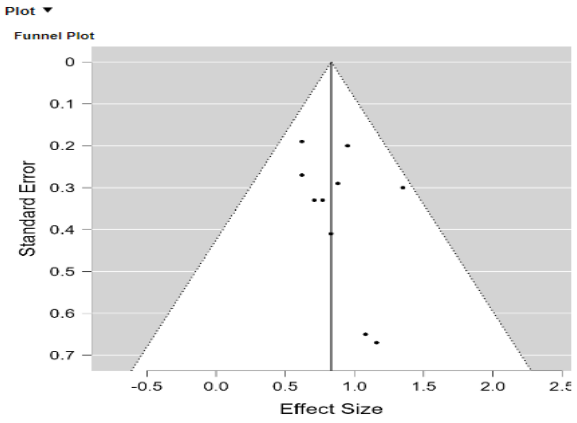

Figure 1. Funnel Plot Standard Error

Based on figure 1. Showing that the *distribution of effect size in* the funnel plot is not yet clearly known whether symmetric or asymmetric, it is necessary to do the *Rosenthal Fasil Safe* N (FSN) test. The results of publication bias analysis with *Rosenthal Fasil Safe* N (FSN) can be seen in Table 4.

Table 4. Rosenthal Fasil Safe N (FSN) Test Results

File Drawer Analysis			
	Fail: Safe-N	**Target Significance**	**Observed Significance**
Rosenthal	275,000	0.050	< 0.001

Table 4. Shows that *Rosenthal Fail Safe (*FSN) value is 275 with a significance value of 0.50 and observed significance of < 0.001. Furthermore, the FSN value is calculated 275 / (5.10) +10 = 3.93 > 1 then in the analysis of 10 studies there is no publication bias. The next step is to calculate the summary effect size or *mean effect size* value from 10 studies. The results of the summary effect size or mean effect size analysis can be seen in the table. 5

Table 5. Summary or mean effect size

	Effect Size	**ONE**	**Z**	**P**	**95 % Confidence Interval**	
					Lower	Upper
Intercept	0.833	0.092	9.061	< 0.001	0.653	1.013

Based on table 5, explain the value of *summary* effect size or *mean effect* size (ES = 0.833 ;SE = 0.092; Z = 9.061) medium criterion. Furthermore, the value of 95% *confindence interval lower* is 0.6 53 and *upper* is 1.013. These results conclude that the inquiry-based learning model is effectively used in mathematics learning compared to conventional learning models.

Research (He et al., 2020; Daniel et al., 2022;Baldock & Murphrey, 2020) The inquiry-based learning model can increase the interest, motivation and learning outcomes of mathematics students so that they are more active in learning. Inquiry-based learning helps students learn more creatively and independently in investigating a problem (Bekteshi &; Avdiu, 2023; Yıldız &; Demirci, 2021). Iquiry-based learning students are directly involved in learning activities so that students more easily understand the material in mathematics learning (Khasawneh et al., 2023).

Furthermore, mathematics learning is required by students to have the ability to think logically and mathematically in learning. Research (Darmayanti &; Sugianto, 2022) in mathematics learning students must have critical thinking and problem-solving skills to make it easier to analyze learning material. In mathematics learning, students must be able to analyze formulas to solve a problem (Thangjai, 2022; Ichsan et al., 2022; Cano &; Lomibao, 2023). Furthermore, the inquiry-based learning model is very effectively applied in mathematics learning. The inquiry-based learning model can improve

students' thinking skills systematically, analytically and logically in mathematics learning (Hidayat et al., 2023; Şen et al., 2021).

CONCLUSION

In this study it can be concluded that the summary effect size or mean effect size value is 0.833 height criteria and values (Z = 9.061; p < 0.001). This finding explains that the inquiry-based learning model has a positive effect on students' mathematics learning compared to conventional models. The inquiry-based learning model helps students think critically and analytically in mathematics learning

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