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Does the Guided Inquiry Model Improve Student's Problem Solving Thinking Ability? Meta-Analysis

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Abstract: The purpose of this study was to investigate the effectiveness of guided inquiry models to improve students' problem-solving abilities. This type of research is a meta-analysis. The inclusion criteria in research are publications from reputable international journals and proceedings; Research must be experimented with guided inquiry learning models and conventional control class models; Research obtained from google scholar database; Hindawi, ScienceDirect, ERIC and IEEE; research related to guided inquiry and problem solving models; The study was published in 2013-2023 and the study had a sample size (N), mean value and standard deviation (SD). The results of the analysis of 18 studies suggest that there is a significant influence of guided inquiry models on problem-solving ability ($Z = 9.29$; $p < 0.001$; 95 % Confidence Interval [0.581; 1.245]. Effect size criteria are high with ($r_{RE} = 0.849$]. This finding explains that the guided inquiry model has a significant effect on students' problem-solving abilities.

Keywords: Effect size; Guided inquiry; Meta-analysis; Problem solving

Introduction

Problem solving is a very important ability possessed by students in facing the 21st century (Yunus et al., 2021; Ummah & Yuliati, 2020). Problem-solving skills train students in making a decision to solve a problem in life (Putri et al., 2019 ; Azrai et al., 2022; Polat, 2023). Furthermore, the ability to solve malasah becomes one of the goals of education (Sambada, 2012; Zulkarnain, 2015; Surur et al., 2020). Students who have problem-solving skills can complete difficult learning (Sari, 2021; Poonputta & Prasitnok, 2022; Ninnuan, 2022). Problem-solving skills can encourage learning achievement in students at school (Doster et al., 2021; Nur et al., 2020).

But in reality, students' problem-solving skills in Indonesia are relatively low (Ilma et al., 2022; Hulaikah et al., 2020; Ariawan & Nufus, 2017). Low problem-solving ability is caused by a learning process that does not train students to have problem-solving skills (Siagian et al., 2019; Setiawan, 2018; Nahdi et al., 2021). Teachers do not involve and direct students to be active in learning (Ichsan et al., 2022; Suryono et al., 2023; Utomo et al., 2023), making it difficult for students to understand lessons. Students are less able to make a decision in solving a problem (Hertiavi et al., 2010; Alfares, 2021; Yasin et al., 2019). The learning model is only teacher-centered (Nurfitriyanti, 2016), making learning activities less interesting. Therefore, teachers must be able to design learning models that can improve students' problem-solving abilities.

The guided inquiry model is a learning model that can stimulate students' problem-solving abilities (Afiyati & Utami, 2020; Puspita et al., 2020). According

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to Eshetu et al. (2022) the *guided inquiry* model is a learning model that guides students in finding material and concepts in learning. The Guided inquiry model can train students to learn more actively because learning is more student-centered (Ford, 2023; Hastuti et al., 2020; Afriani & Agustin, 2019). The *guided inquiry* model can train students' understanding in understanding concepts in learning (Owolade, 2022; Margunayasa et al., 2019).

Previous research guided inquiry model has a positive influence on science literacy and science process skills as well as students' understanding of concepts (Put et al., 2019; Seranica et al., 2018; Gumilar & Wardani, 2020; Ristanto et al., 2017). Research by Lungan et al. (2018) said the guided inquiry model can improve students' communication skills in the learning process. In addition, the guided inquiry model can foster students' motivation and critical thinking skills in finding concepts and materials (Aiman et al., 2020; True et al., 2021). There are many studies on the guided inquiry model but no research has been found related to how much effect the size of the inquiry model and student problem solving. Based on these problems, this study aims to determine the effectiveness of the *guided inquiry* model to improve students' problem-solving abilities. The findings of the research meta-analysis will make an important contribution to the application of the *guided inquiry model.*

Method

Design Research

This research is a type of meta-analysis research. Meta-analysis is research that traces the literature from primary sources that can be analyzed quantitatively (Balemen, 2018; Öztürk et al., 2022; Oktarina et al., 2021; Putra et al., 2023; Kaçar et al., 2021; Rahman et al., 2023; Aybirdi, 2023). This meta-analysis study serves to determine the influence of guided inquiry and students' problem-solving abilities. According to Borenstein et al. (2007) the steps to conduct meta-analysis research are determining inclusion criteria; Collecting literature; conduct a literary screening process; data coding and analysis.

Inclusion Criteria

The relevant inclusion criteria in this study are research published from 2015-2023; research must be experimental or quasi-experimental methods; research related to guided inquiry and problem solving models; The study must report complete data to calculate the effect size; Research must come from highly reputable journals or proceedings.

Litearetur Collection and Screening

The literature collection process is through the databases Google Scholar, ERIC, ProQuest and ScienceDirect. The keywords used in literature search are: "the effect of guided inquiry models on problem-solving skills". The process of filtering data by means of *identification; screening; eligibility* and *included.* The screening results obtained 14 studies for meta-analysis materials.

Coding Data

The data coding in this meta-analysis is done systematically to avoid errors. Data coding in this study consists of author name, year of publication, publication index and effect size.

Data Analysis

Data analysis in the meta-analysis study is guided by (Borenstein et al., 2009) which can be seen in Figure 1.

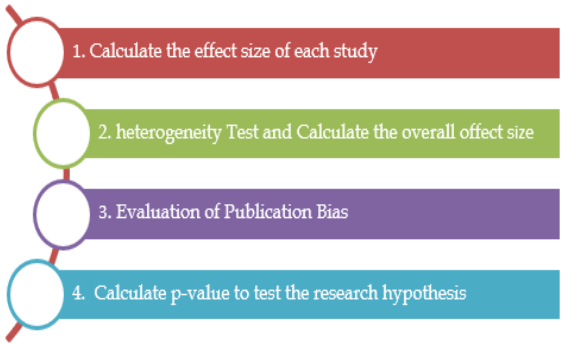

Figure 1. Data analysis steps in meta-analysis

Data analysis in this meta-analysis study with JSAP software. The effect criteria in this study are guided by the effect size criteria (Cohen et al., 2007) can be seen in Table 1. To ensure validity and avoid research bias in meta-analysis research, it is necessary to check publication bias (Nurhayati et al., 2023; Baysal et al., 2023; Chamdani et al., 2022; Aspiranti et al., 2021; Çevik & Bakioğlu, 2022). Reducing the value of publication bias with Egger's test (Aaron et al., 2021; Ridwan et al., 2013; Chamdani et al., 2022).

Table 1. Effect Size Criteria

Effect Size	Criterion
0.00 ≤ ≤ 0.20	Low
0.20 ≤ ≤ 0.80	Medium
d ≥ 0.80	High

Result and Discussion

Results In meta-analysis research, the first step is determining the effect size of each study analyzed. The

results of the analysis of 14 effect sizes of this study obtained through JSAP software are shown in Table 2.

Table 2. Results of Effect Size Analysis of Each Study

Code	Writer	Index	Effect Size	95 % Confidence Interval	
				Low Bound	Upper Bound
N1	Puspita et al. (2020)	SINTA	1.42	0.812	0.957
N2	Sanggara et al. (2018)	SINTA	0.87	0.441	1.342
N3	Irwanto et al (2018)	Scopus	2.24	0.672	1.749
N4	Kurniashih & Syarifuddin (2019)	WoS	0.95	0.723	1.518
N5	Wafi & Arif (2020)	SINTA	0.78	0.656	1.340
N6	Bahiyah (2019)	SINTA	0.84	0.472	0.911
N7	Divrik et al. (2020)	Scopus	0.97	0.533	1.282
N8	Muhammad & Purwanto (2020)	Scopus	0.64	0.471	0.908
N9	Riskayanti (2023)	SINTA	1.14	0.619	1.271
N10	Agustina et al. (2020)	SINTA	0.87	0.430	0.914
N11	Ardhana (2020)	SINTA	0.79	0.382	0.812
N12	Sayyadi et al. (2016)	SINTA	0.62	0.315	0.782
N13	Scott & Hilt (2019)	Scopus	2.20	0.754	1.652
N14	Igboanugo (2023)	Scopus	0.91	0.517	1.015

Table 2 describe the results of the analysis of 14 effect sizes from each study that has met the inclusion criteria. The effect size value ranges from 0.62 to 0.79 and the lower limit is 0.315 and the upper limit is 1.340 k. Furthermore, the effect size value ranges from 0.84 to 2.24 and the lower limit is 0.472 and the upper limit is 1.749. Based on the effect size criteria according to (Cohen et al., 2007) four medium criteria effect size and ten high criteria effect size were obtained . Next, conduct a heterogeneity test of the 14 effect sizes analyzed. Test results of the overall heterogeneity of the study can be seen in Table 3.

Table 3. Heterogeneity Test Results

	Q	Df	P
Omnibus test of Model Coefficients	86.363	1	< 0.01
Test of Residual Heterogeneity	12.117	13	< 0.01

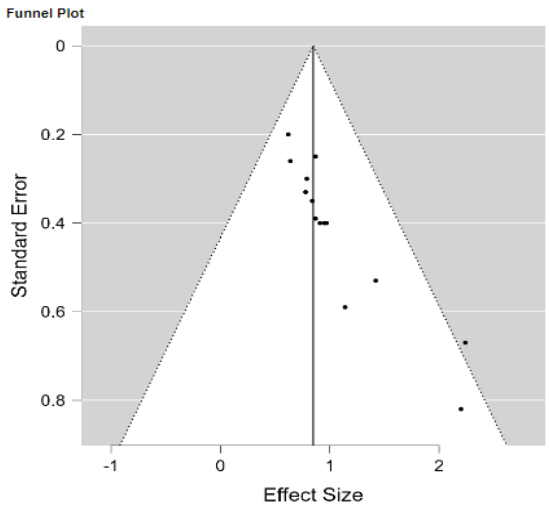

Figure 2. Funnel plot standard error

Based on Table 3, describing the results of the heterogeneity test obtained values (Q = 86.363; p < 0.001), hence the overall heterogeneous distribution of the study. Next, analyze the *summary* effect size or mean effect size. Next, check publication bias to avoid bias from the entire research analyzed. Checking publication bias in meta-analyses is essential to maintain data validity (Yücelyiğit &; Toker, 2021; Bir et al., 2021). Publication bias is checked with Egger's funnel plot and test. The results of checking publication bias with funnel flot can be seen in Figure 2.

Based on figure 2, effect size funnel plot analysis is difficult to determine whether the curve bump on the vertical line is symmetrical or symmetric. Therefore, it is necessary to do Egger's test. Egger's test results are shown in Table 4.

Table 4. Egger's Test Results

	Z	P
Sei	2.904	0.004

Table 4, explains the value of Z = 2.904 with p < 0.004. These results conclude that the funnel plot is symmetrical. In addition, these results explain that there is no publication bias from the 14 studies analyzed. Next, analyze the summary effect size / mean effect size to find out the p-value in testing the hypothesis. The results of the summary effect size analysis can be shown in Table 5.

Table 5. Summary Effect Size

	Estimate	Standard Error	Z	P	95 % CI Lower	Upper
Intercept	0.84	0.260	9.293	0.001	0.581	1.245

Based on Table 5, explaining the results of the summary effect size analysis is obtained by the value of the Confidence Interval 95% lower of 0.581 and upper 1.245. Value (Z = 6.082; p < 0.001) then the application of the guided inquiry model has a significant effect on students' problem-solving abilities. The effect of the guided inquiry model on the problem-solving ability of high criteria with (r_E = 0.84; SE = 0.260). In addition, the summary effect size can be depicted with a forest plot. Forest flot in the meta-analysis serves to see the estimated summary effect size by paying attention to interval points (Kazu &; Yalçın, 2021). The results of the summary effect size analysis with *forest plot* can be seen in Figure 3.

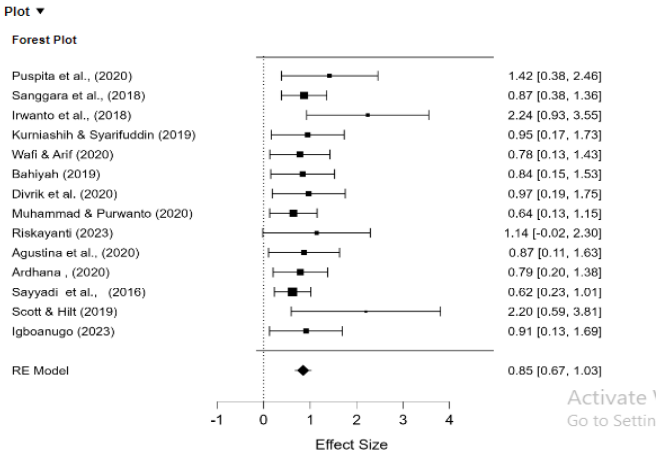

Figure 3. Forest plot

Based on Figure 3, analyzing the effect size with a forest plot obtained an effect size value that varies from 0.62 to 2.24 So, the results of 14 effect sizes analyzed show that the application of the *guided inquiry learning* model has a positive influence with a high category on students' problem-solving abilities. The findings of this study are in line with Cindikia et al. (2020) The guided inquiry model has a significant influence on students' problem-solving abilities. These findings support research (Irwanto et al., 2018; Şen & Yılmaz, 2015) The *guided inquiry* model shows a positive influence in improving students' problem-solving skills and confidence in learning.The teacher's *guided inquiry model* guides students in finding concepts, principles and subject matter independently carried out by students (Lestari et al., 2018; Nurani et al., 2018; Astrian, 2022). Furthermore, the *guided inquiry* model increases interest and motivation that can stimulate problem-solving abilities (Rusdi et al., 2019; Hyland et al., 2021).

Furthermore, the *guided inquiry* model allows students to learn more actively and creatively in learning (Rands et al., 2021), so as to stimulate students to think critically in solving a problem (Ulfa et al., 2022; Lestari et al., 2020). The inquiry learning model is effective for developing students' thinking processes in learning (Widiana et al., 2019; Fortmann et al., 2020). According to Light et al. (2020) The guided *inquiry* model can encourage students' creativity and linguistic ability in learning. In addition, the guided inquiry model of students can increase confidence in conveying ideas or ideas in solving a problem. Problem-solving skills provide an important role for students in making a decision (Gholami, 2023; Özpinar & Arslan, 2023). Students who have problem-solving skills are easier to understand lessons (Widodo, 2023; Mahanal et al., 2022).

Conclusion

In this study it can be concluded that there is a significant influence of the guided inquiry model on the ability to solve problems (Z = 9.29; p < 0.001; 95 %) Confidence Interval [0.581; 1,245]. Effect size criteria are high with (rRE = 0.84). This finding explains that the guided inquiry model has a significant effect on students' problem-solving abilities. The guided inquiry model allows students to learn independently in finding concepts so that they can encourage problem-solving skills in learning. Furthermore, the guided inquiry model of the learning process centers on students and teachers as facilitators in learning activities

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Conflicts of Interest
The authors declare no conflict of interest.

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