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THE INFLUENCE OF THE USE OF POLYA'S HEURISTIC STRATEGIES ON STUDENTS' MATHEMATICAL PROBLEM SOLVING: A META ANALYSIS

(Pengaruh Penggunan Strategi Heuristik Polya terhadap Pemecahan Masalah Matematis Siswa: Sebuah Meta-Analisis)

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Abstract

Mathematics education in Indonesia faces significant challenges, as reflected in the low performance of students in various international assessments. Traditional teaching methods, which are less interactive, are considered one of the key factors contributing to students' low problem-solving abilities in mathematics. This meta-analysis aims to evaluate the impact of Polya's heuristic model on students' mathematical learning outcomes and determine the extent to which this strategy can enhance students' learning abilities compared to conventional teaching methods. The study employs a meta-analytic approach, integrating data from 15 primary studies conducted between 2014 and 2023, and uses statistical analysis to calculate the average effect size of the implementation of Polya's heuristic model in mathematics education. The findings reveal a significant improvement in students' mathematical learning outcomes using Polya's heuristic model, with an average effect size of 1.13, categorized as "very high." The study suggests that the application of Polya's heuristic model is significantly more effective in enhancing students' mathematical learning outcomes than conventional teaching methods. The practical implication is that educators and policymakers in Indonesia could consider adopting this strategy in curricula and teacher training programs to improve the quality of mathematics education.

Kata kunci:
Polya heuristic Strategies, mathematics learning outcomes, meta-analysis, Problem-solving ability in mathematics

Abstrak

Pendidikan matematika di Indonesia menghadapi tantangan besar, tercermin dari rendahnya performa siswa dalam berbagai asesmen internasional. Metode pengajaran tradisional yang kurang interaktif dianggap sebagai salah satu faktor utama rendahnya kemampuan pemecahan masalah siswa. Meta-analisis ini bertujuan mengevaluasi dampak model heuristik Polya terhadap hasil belajar matematika serta sejauh mana strategi ini meningkatkan kemampuan siswa dibanding metode konvensional. Studi ini menggunakan pendekatan meta-analitik dengan mengintegrasikan data dari 15 studi primer (2014–2023), serta analisis statistik untuk menghitung rata-rata ukuran efek penerapan model heuristik Polya dalam pendidikan matematika. Temuan menunjukkan peningkatan signifikan pada hasil belajar siswa, dengan rata-rata ukuran efek sebesar 1,13 yang dikategorikan "sangat tinggi." Studi ini menyimpulkan bahwa penerapan model heuristik Polya secara signifikan lebih efektif dalam meningkatkan hasil belajar matematika dibanding metode konvensional. Implikasi praktisnya, pendidik dan pembuat kebijakan di Indonesia dapat mempertimbangkan strategi ini dalam kurikulum dan pelatihan guru guna meningkatkan kualitas pendidikan matematika.

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INTRODUCTION

Mathematics education in Indonesia faces significant challenges, which are reflected in low student performance in various international evaluations (Djam'an et al., 2023; Nandang Mustafa, 2023). The PISA (Program for International Student Assessment) 2022 report shows that Indonesian students' mathematics ability is well below the international average, showing the need for deep reform of the approach to teaching mathematics in schools (OECD, 2023). The low results of students' mathematics studies are often caused by a lack of ability to solve problems and think mathematically (Rosnawati, 2013). A number of studies show that Indonesian students still face difficulty in applying draft mathematics to real situations and are less capable of solving complex problems (Wahab A et al., 2023). Based on PISA (Program for International Student Assessment) 2018 report, the mathematics ability of Indonesian students is below the international average, which reflects the necessity of enhancing the quality of teaching mathematics in schools (OECD, 2023).

One of the contributing factors to low ability mathematics students is ongoing teaching methods that are traditional in nature and less interactive (Sitopu, 2023). This method often does not give students the opportunity to be actively involved in the learning process, which ultimately has a low impact on students' analytical and critical abilities (Wardhani & Nduru, 2023). According to (NCTM, 2020), an effective teaching approach must be capable of developing high-level thinking abilities, including solving problems, reasoning, and communicating mathematically.

This research is important to overcome the problem because innovative teaching approaches, such as Polya's heuristic models, can provide effective solutions. This strategy emphasizes systematic steps in problem solving, which can help students develop critical and analytical thinking skills (Polya, 1978). Polya Models consists of four stages, namely understand problems, planning completion, carrying out plan, and check return results. These stages provide a clear framework for students to work on solving mathematical problems (Wahab, 2022).

Previous studies have shown that application of the Polya model in learning mathematics can increase students' learning outcomes and problem-solving abilities. (Valverde Riascos et al., 2022) found that this method can increase students' positive attitude to mathematics and improve their ability to solve complex problems. (Hattie, 2008) in his meta-analysis also stated that learning strategies are put forward solution problem has a high effect size in increase results study student.

Furthermore, research by (Nurdin et al, 2020) revealed that use of the Polya model can increase student involvement in the learning process and help them understand

mathematical concepts in a more in-depth way (Siswanto & Yulaikah, 2023). These results are consistent with findings from international studies showing that the heuristics approach not only increases study results but also strengthens critical thinking skills and conceptual abilities of students (Astuti, 2015).

The aim of this research is to evaluate the influence of the Polya model heuristic approach on student mathematics learning outcomes in Indonesia. This research also aims to determine the extent to which this strategy can improve students' learning abilities compared to conventional learning models. Thus, it is hoped that the results of this research can provide a strong foundation for developing more effective curriculum and teaching strategies in Indonesian schools. It is hoped that this research can provide new insights for educators and policy makers in designing more effective teaching methods.

METHODS

This research adopts a meta-analysis method, which involves systematically reviewing and statistically analyzing the results of multiple individual studies using a quantitative approach(Kumar L, 2021). The stages in the meta analysis adopted the stages of (Becker & Thompson, 2023), including: (1) Formulate question research and determine relevant research. At this stage the researcher also determine the criteria inclusion in the desired literature studied . Furthermore literature that passes the criteria inclusion done coding; (2) Heterogeneity Test. This stage is for determine method estimation from meta analysis research used. (3) Calculating the effect size. Findings quantitative in research Primary studies were integrated and compared in a way statistics with using assisted effect size with JASP software; (4) Funnel Plot test publication bias test, and strengthened with Fail Safe N test; and (5) Interpretation and conclusions from results analysis. The research procedure consists of several stages, such as determining inclusion criteria, collecting data from primary studies, extracting data, and conducting statistical analysis.

Criteria Inclusion

The inclusion criteria in this research use the PESCO framework, which consists of the following (1) Population: Population is the primary study of students in Indonesia. (2) Intervention: Primary study uses learning with Polya's heuristic strategy approach as a classroom intervention experiment. (3) Comparison: Primary study class control using a conventional learning model. (4) Outcomes: The results of the primary study are: results Study mathematics students. (4) Study Design: Primary study is a quantitative study using the quasi-experimental method. (5) Primary studies provide statistical data like average, standard deviation, and size of future samples used in calculating the effect size. (6)

Primary studies are published between 2014 to 2023. (7) Primary studies in the form of journal articles, proceedings and theses. If the primary studies do not fulfill the specified inclusion criteria, it will be excluded from this research.

Data collection

The study selection process follows the PRISMA flow diagram for systematic reviews shown in figure 1. Primary study data were obtained from the Publish or Perish (POP) database as well as Google Scholar manual search with using the keyword "Penerapan Polya",“ Polya terhadap Hasil belajar ”, and “Penerapan Polya terhadap Hasil Belajar". All searches imported from Perish undergo selective processing, starting with filtering the titles and, if needed, the abstracts to assess relevance. Papers that pass this stage are then further screened based on specific inclusion and exclusion criteria, which guide the second phase of the review through the Covidence management system. Reviewers evaluate each item to determine its eligibility according to the inclusion criteria.

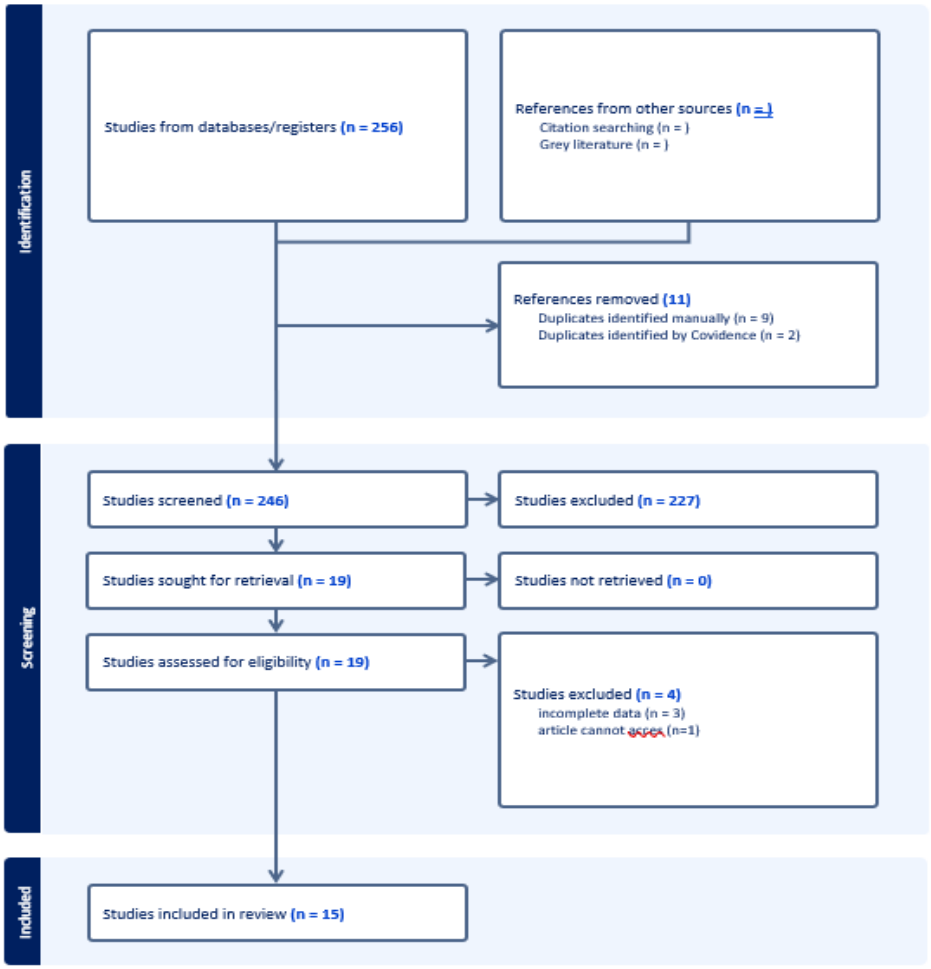

Figure 1
PRISMA flow diagram from Covidence

Data Extraction

The criteria for article inclusion are carefully documented using a coding sheet. This sheet contains detailed data such as the researchers involved, sample size, year of publication, source of publication, as well as the mean and standard deviation values for both the control (conventional) group and the experimental group. This structured approach ensures consistent and thorough extraction of relevant information for analysis.

Statistical Analysis

Empirical data results data extraction will converted and used in effect size calculation. This research uses Hedge's formula with Jeffrey's Amazing Statistics Program (JASP) software. The results of the effect size calculation are interpreted with use criteria that have been determined by Thalheimer and Cook are presented in Table 1.

Table 1.
Effect size criteria

Intervals	Criteria
$ES \leq 0{,}15$	Ignored
$0{,}15 < ES \leq 0{,}40$	Small
$0{,}40 < ES \leq 0{,}75$	Currently
$0{,}75 < ES \leq 1{,}10$	Tall
$1{,}10 < ES \leq 1{,}45$	Very high
$ES > 1{,}45$	Very good

(Juandi et al., 2021)

Furthermore, determining the overall effect was carried out using a random-effects model. The choice of this method was based on the results of the data extract which showed no heterogeneity in effect sizes between the studies.

Resultsdan Discussion

Results

Based on Figure 1, in total, 256 references have been identified and 11 was excluded because it was a duplicate of another reference. Furthermore, 227 of the 246 references identified were deleted because they did not match the inclusion criteria at the title screening stage. This process resulted in 19 items for further examination. After accessing the full text of the references, another 2 items were removed. The reasons for this were no access (n = 1), and incompleate data (n = 3). The final synthesis and analysis included

fifteen (n = 15) peer-reviewed journal article references. Statistical data extraction results from coding of 15 primary studies are presented in Table 2.

Table 2. Data ekstraction result

Code	Citation	Heuristic Strategi Polya			Convensional Strategi		
		Xe	SDe	Ne	Xc	SDc	Nc
R1	(Dewi, 2013)	81.14	9.57	36	75.25	10.93	36
R2	(Yani, 2018)	78.6	8.51	30	71.40	6.11	30
R3	(Anugraheni, 2019)	76.2	9.36	30	63.81	8.33	30
R4	(Kartini et al., 2020)	73.74	21.18	23	32.46	18.30	26
R5	(Nurkhaffah & Mahmudi, 2018)	84.25	13.35	32	73.25	14.95	32
R6	(Pratiwi Handayani et al., 2017)	75.84	14.23	43	56.72	19.72	43
R7	(Purwanti, 2021)	78.33	8.96	30	65.00	13.28	30
R8	(Wibisono, 2017)	82.33	7.42	18	67.22	10.17	18
R9	(Apryanti et al., 2015)	70.7	17.36	40	57.21	21.97	40
R10	(Wilanda Nata Karya, 2019)	83	7.40	20	68.00	9.54	20
R11	(Asman & Ariani, 2020)	81.32	12.56	38	71.86	12.29	36
R12	(Harinda et al., 2023)	80.04	11.53	50	72.46	15.38	45
R13	(Ayustina & Ahmad, 2020)	85	5.20	23	74.00	5.10	23
R14	(Wirawan et al., 2019)	48.84	5.22	24	44.28	6.31	25
R15	(Putri et al., 2018)	87.19	9.62	11	73.09	8.10	11

Description :
Xe: The average score of the class using the Polya Heuristic Strategy.
Xc: The average score using the Conventional Strategy.
SDe: The standard deviation of scores using the Polya Heuristic Strategy.
SDc: The standard deviation of scores using the Conventional Strategy.
Ne: The number of participants for the Polya Heuristic Strategy.
Nc: The number of participants for the Conventional Strategy.

Based on the table above, it shows that results extraction from appropriate studies criteria inclusion at least load some important data related information amount sample, standard deviation for each group, as well as the post test average from each group with heuristic strategy intervention Polya and Convensional Strategis.Article research that has been extracted Then analyzed with look for the average effect size score. The effect size value is used to describe the extent of the influence of the Polya heuristic model on student mathematics study results. The average score of the measure effect can be seen in table 3.

Table 3. Effect size each study

Code	Effect Size	Vd	SEd	Effect category
R1	0.57	0.06	0.24	Currently
R2	0.96	0.07	0.27	Tall
R3	1.38	0.10	0.31	Very high
R4	2.06	0.08	0.29	Very good

R5	0.76	0.17	0.41	Tall
R6	1.10	0.05	0.23	Tall
R7	1.16	0.14	0.37	Very high
R8	1.66	0.22	0.46	Very high
R9	0.67	0.05	0.23	Currently
R10	1.72	0.10	0.31	Very good
R11	0.75	0.06	0.24	Currently
R12	0.56	0.04	0.21	Currently
R13	2.10	0.15	0.38	Very good
R14	0.77	0.08	0.28	Tall
R15	1.53	0.24	0.48	Very good

Description :
Vd : Variance from *Effect Size*
SEd : Standard Error *Effect Size*

Based on table 3, can is known that there were 26.67% of studies that obtained The effect size value is in the very good category, 26.67% of research obtained The effect size value is in the very high category, 26.67% of research obtained effect size value in the category high , meanwhile For category currently obtain percentage by 20%. Besides that, it also looks like that error standard size the effect obtained is below 0.5%. The result describe that size the effect obtained own level 95% confidence.

After knowing mark size effect For every analyzed studies, steps furthermore is count effect summary. Effect summary is summary effect or average effect of various study. This research uses a random effect model, so the data must be fulfil assumption heterogeneity. I^2 is one method that can be used to test heterogeneity. I^2 depicts the proportion of variation in the summary effect size on a scale of 0% to 100%.

Table 4. Residual Heterogeneity Estimates

		95% Confidence Interval	
	Estimate	**Lower**	**Upper**
τ^2	0.173	0.056	0.592
τ	0.416	0.236	0.769
I^2 (%)	67.574	40.161	87.709
H^2	3.084	1.671	8.136

Collected data in this research is shown in table 4 results $I^2 = 67{,}574\% > 25\%$ fulfil appropriateness said heterogeneous. Furthermore selection of appropriate random effect models with criteria can seen from effect whole through Figure 1 following forest plot.

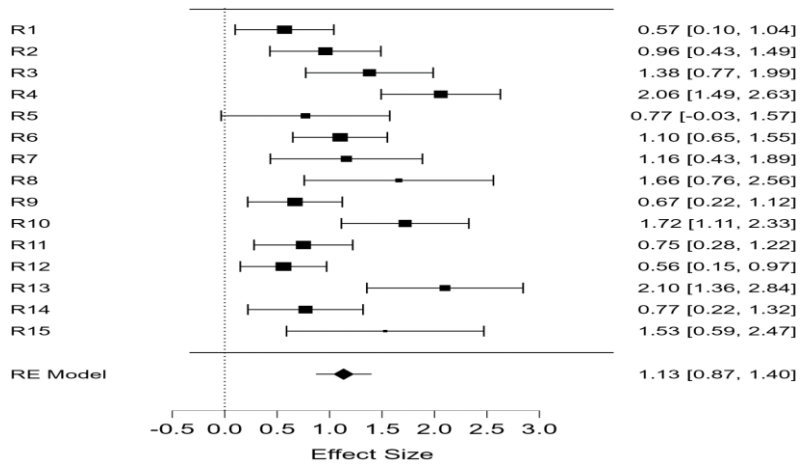

Figure 1.
Random Effect Model

Data in forest plot above shows effect summary 1.13. It means that there is a very high influence for the use of heuristic strategies Polya to results Study mathematics students. Besides that, with 0.95% confidence, it is known that the range effect summary 0.87 to 1.40 does not contain zero. This shows that there is a clear significant difference between integrated learning with a heuristic Strategi Polya and conventional learning. Next, bias analysis was carried out in meta-analysis. This analysis is very important to show validity conclusion in study because of the meta-analysis can be considered biased if only take study with desired and undesirable results displays results research that accepts hypothesis zero or give conclusion negative.

From analysis of this research, it looks like the effect size shifted when research that does not published was entered in meta-analysis. Following are publication bias test results with Funnel Plot, and strengthened with the Fail Safe N test.

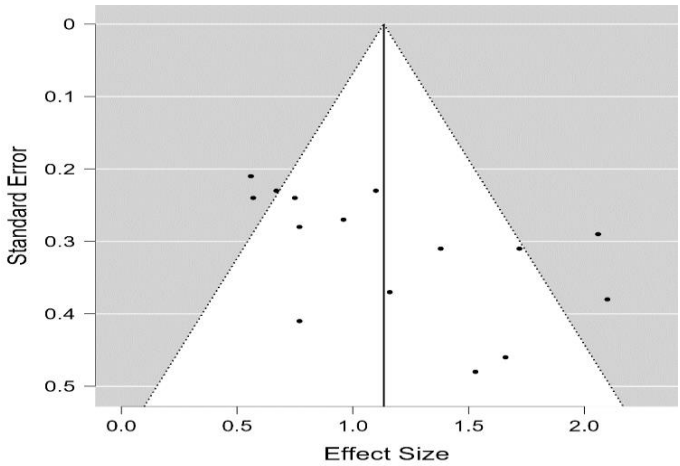

Figure 2.
Funner Plots Result

Funnel plot with fixed-effect model shown in Figure 2 above show that from 15 studies No There is point empty circle, meaning that whole study published, because that study regarding data on the influence of the Polya heuristic model to results study no own potency biased publication. This is reinforced with image Safe N file value 2, because $K = 15, so\ 5K + 10 = 5(15) + 10 = 750$. The fail safe value N obtained namely 1170, with a target significance of 0.05 and $p < 0.001$. Because the Fail-safe value $N > 5K + 10$, then can concluded that there is the issue of publication bias in studies meta-analysis . This shows conclusions made based on the fixed-effect model regarding influence approach Polya model heuristics to results learning is valid.

Table 5
File Drawer Analysis

	Fail-safe N	Target Significance	Observed Significance
Rosenthal	1170.000	0.050	< .001

Discussion

This research examines effectiveness approach Polya model heuristics in increase results Study mathematics students in Indonesia. Based on the meta- analysis carried out, it was found that approach heuristics Polya own influence significant to ability solution problem mathematical student compared to with a learning model conventional. Of the 15 primary studies analyzed, all studies show that approach heuristics Polya give effect significant positive to results Study mathematics student . The average value of the effect size is calculated is 1.13, which includes in very high category according to (Juandi et al., 2021). This shows that use of heuristic strategies Polya in a way consistent increase ability solution problem mathematical student with high effectiveness.

According to (Polya, 1978) important For develop habit think critical and reflective in the solving process problem , the framework presented has proven effective to solution problem especially in studies very close mathematics related with problem solving. This study is in line with what was stated by (Schoenfeld, 1985) that use approach Polya in learning mathematics can increase ability think critical students and abilities they in finish problem mathematics. In summary SLR research from (Hattie, 2008) explain that taught students more strategic problem solving approach Good compared to with group control that uses method conventional.

More further, research by (Hattie, 2008) show that learning strategies are put forward solution problem has a high effect size in increase results Study student. This result is supported by (Schoenfeld, 2016) who states that problem solving approaches, including the Polya model, are effective in increase understanding conceptual and skills mathematical student. The results of this research provide significant contribution to development

knowledge knowledge, esp in field education mathematics. With confirm effectiveness approach heuristics Polya, this research is reinforcing argument that learning strategies involve thinking processes critical and solving problem can increase results Study student in a way significant.

Implications practical from this research is that educator and taker policy education in Indonesia can consider For adopt approach heuristics Polya as one of the main strategies in teaching mathematics. Remember its proven effectiveness, this approach can become deep powerful tool increase results learning and abilities solution problem student.

CONCLUSION

This research shows that approach Polya model heuristics in a way significant more effective in increase results Study mathematics student compared to with a learning model conventional. Meta- analysis results of 15 primary studies revealed that Polya strategy give effect consistently positive with The average value of the effect size is very high, supporting it hypothesis that use this approach can increase ability solution problem mathematical student. Implications practical in this research suggests educators and makers policies in Indonesia can consider For integrate this strategy into in curriculum and teacher training programs, use reach more improvement significant in education mathematics in various level school. Further research could explore the application of the Polya heuristic model in broader contexts, including variations in teaching methods and their impact on students' non-cognitive skills.

CONFLICT OF INTEREST

The authors of this manuscript declare that we are free from conflicts of interest regarding the publication of this manuscript. In addition, matters relating to violations of plagiarism, falsification of data and/or, duplication of publications, as well as matters relating to ethical issues of publication have been fully resolved and held accountable by the authors.

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REFERENCES

Anugraheni, I. (2019). Pengaruh Pembelajaran Problem Solving Strategi Polya Terhadap Kemampuan Memecahkan Masalah Matematika Mahasiswa. *Jurnal Pendidikan (Teori Dan Praktik)*, *4*(1), 1. https://doi.org/10.26740/jp.v4n1.p1-6

Apryanti, H., Isamil, F., & Firtianti, Y. (2015). Penerapan Teknik Pemecahan Masalah Strategi Polya Terhadap Kemampuan Menyelesaikan Soal Cerita Matematika Pada Siswa Kelas Viii Smp Negeri 46 Palembang. *Jurnal Pendidikan Matematika RAFA*, *1*(2), 224–243. http://jurnal.radenfatah.ac.id/index.php/jpmrafa/article/view/1232

Asman, N. E., & Ariani, Y. (2020). Strategi Polya Terhadap Hasil Belajar Soal Cerita Penjumlahan dan Pengurangan Pecahan Kelas V SD. *Journal of Basic Education Studies*, *3*(2), 279–290.

Astuti, S. (2015). Pengembangan Perangkat Pembelajaran Berbasis Problem Solving Strategi Polya Dalam Peningkatan Keterampilan Berpikir Kritis Pokok Bahasan Barisan Bilangan Siswa Kelas IX SMP Negeri 3 Kota Probolinggo. *Pancaran Pendidikan*, *4*(4), 149–162.

Ayustina, S., & Ahmad, S. (2020). Pengaruh Strategi Polya Terhadap Hasil Belajar Soal Cerita di Sekolah Dasar. *Jurnal Pendidikan Tambusai*, *4*(3), 2768–2778. https://doi.org/10.31004/jptam.v4i3.772

Becker, B. J., & Thompson, C. G. (2023). Meta-analysis. In *International Encyclopedia of Education(Fourth Edition)* (pp. 842–859). Elsevier. https://doi.org/10.1016/B978-0-12-818630-5.10092-2

Dewi, R. (2013). *Pengaruh Penerapan Strategi Heuristik Strategi Polya Terhadap Kemampuan Pemecahan Masalah Matematika Siswa SMP Negeri 2 Pekanbaru*. UIN Suska Riau.

Djam'an, N., Mariana, N., & Simanjorang, M. M. (2023). *Trends in Mathematics Education Research in Indonesia* (pp. 163–175). Springer, Singapore. https://doi.org/10.1007/978-981-99-0643-7_8

Harinda, V. D., Tumalun, N. K., & Regar, V. E. (2023). Pengaruh Langkah Polya Terhadap Hasil Belajar Siswa dalam Menyelesaikan Soal Cerita Barisan dan Deret Geometri. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *7*(3), 2349–2358. https://doi.org/10.31004/cendekia.v7i3.2572

Hattie, J. (2008). Visible Learning. In *Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement*. Routledge. https://doi.org/10.4324/9780203887332

Juandi, D., Kusumah, Y. S., Tamur, M., Perbowo, K. S., & Wijaya, T. T. (2021). A meta-analysis of Geogebra software decade of assisted mathematics learning: what to learn

and where to go? *Heliyon*, *7*(5), e06953. https://doi.org/10.1016/j.heliyon.2021.e06953

Kartini, H. A., Ario, M., & Sari, R. N. (2020). Pengaruh Pendekatan Pembelajaran Problem Solving Strategi Polya terhadap Kemampuan Pemecahan Masalah Matematis Siswa Kelas VIII SMP Muhammadiyah Rambah. *Jurnal Pendidik Indonesia*, *1*(1), 17–24. https://doi.org/10.61291/jpi.v1i1.4

Kumar L, M. (2021). Meta-analysis as a research design – steps demystified for novice medical researchers: a brief review. *Kerala Journal of Psychiatry*, *34*(2). https://doi.org/10.30834/KJP.34.2.2021.293

Nandang Mustafa, A. (2023). Reflection on The Latest PISA Results of Indonesia. *International Journal of Advanced Research*, *11*(05), 1223–1228. https://doi.org/10.21474/IJAR01/16988

NCTM. (2020). *Principles and standards for school mathematics*. National Council of Teachers of Mathematics. https://www.nctm.org/standards

Nurkhaffah, P. S., & Mahmudi, A. (2018). Efektivitas Pembelajaran CTL Berbasis Pemecahan Masalah Strategi Polya Terhadap Kemampuan Pemecahan Masalah Siswa. *Jurnal Pendidikan Matematika Dan Sains*, *7*(1), 1–12.

OECD. (2023). *PISA 2022 Results (Volume I)*. OECD. https://doi.org/10.1787/53f23881-en

Polya, G. (1978). How to solve it: a new aspect of mathematical method second edition. In *The Mathematical Gazette* (Vol. 30, p. 181). http://www.jstor.org/stable/3609122?origin=crossref

Pratiwi Handayani, S., Rutami, M. R., & Ramlah. (2017). Pengaruh Pendekatan Problem SolvingStrategi Polya Terhadap KemampuanPemecahan Masalah Matematis Siswa Smp. *Prosiding Seminar Nasional Matematika Dan Pendidikan Matematika (SESIOMADIKA)*, *2000*, 393–400.

Purwanti, Y. (2021). *Penerapan Langkah Polya Dalam Menyelesaikan Soal Pemecahan Masalah Matematis Pada Siswa Kelas 3 Sdn 17 Lubuk Besar* [Universitas Muhammadiyah Bangka

Putri, A. R., Masniladevi, & Desyandri. (2018). Pengaruh Penggunaan Metode Problem Solving Strategi Polya Terhadap Hasil Belajar Soal Cerita di Sekolah Dasar The Effect of Using Problem Solving Method with Polya Model to Students Learning Outcome About Narrative Story In Elementary School. *E-Journal Pembelajaran Inovasi, Jurnal Ilmiah Pendidikan Dasar*, *6*(2), 19–32. http://ejournal.unp.ac.id/students/index.php/pgsd/article/view/5734/3012

Rosnawati, R. (2013). Kemampuan Penalaran Matematis Siswa SMP Indonesia pada

TIMSS 2011. *Prosiding Seminar Nasional Penelitian, Pendidikan Dan Penerapan MIPA*, 1–6.

Schoenfeld, A. H. (1985). *Mathematical Problem Solving*. Academic Press. https://doi.org/10.1016/C2013-0-05012-8

Schoenfeld, A. H. (2016). Learning to Think Mathematically: Problem Solving, Metacognition, and Sense Making in Mathematics (Reprint). *Journal of Education*, *196*(2), 1–38. https://doi.org/10.1177/002205741619600202

Siswanto, S., & Yulaikah, Y. (2023). Implementation of Cognitive Learning Theory in Polya Learning to Improve Mathematical Problem Solving Ability. *Jurnal Analisa*, *9*(1), 48–58. https://doi.org/10.15575/ja.v9i1.25026

Sitopu, J. W. (2023). Kemampuan Komunikasi Matematis Siswa Melalui Budaya Literasi Dan Numerasi Siswa. *Pendas : Jurnal Ilmiah Pendidikan DasarPendidikan Dasar*, *8*(1), 356–363.

Valverde Riascos, Y. del S., Valverde Riascos, O. O., & Vallejo Ramirez, S. P. (2022). El Método Polya como estrategia pedagógica para la resolución de problemas matemáticos (RPM). *Revista Científica Ecociencia*, *9*(5), 105–130. https://doi.org/10.21855/ecociencia.95.717

Wahab, A. (2022). Diagnosa Kesulitan Siswa Dalam Menyelesaikan Soal SPLTV Melalui Pemetaan Kognitif Berbasis Polya dan Upaya Mengatasi dengan Scaffolding. *RAINSTEK : Jurnal Terapan Sains & Teknologi*, *4*(1), 1–14.

Wahab A, A., Buhaerah, B., Ahsan, M., & Busrah, Z. (2023). Mapping students' thinking structure in solving PISA-like problems: Errors and defragmentation. *Beta: Jurnal Tadris Matematika*, *16*(2). https://doi.org/10.20414/betajtm.v16i2.545

Wardhani, M. K., & Nduru, M. (2023). Method of learning through play to facilitate the activeness of kindergarten students. *Jurnal Pendidikan Dasar Nusantara*, *8*(2), 250–262. https://doi.org/10.29407/jpdn.v8i2.19185

Wibisono, A. A. (2017). *Perbedaan Efektivitas Penerapan Model Problem Solving Berbantuan Teori Polya Terhadap Kemampuan Pemecahan Soal Cerita Matematika Kelas Iv Sd Negeri Gugus Kanigoro Salatiga* [Universitas Kristen Satya Wacana]. https://repository.uksw.edu/handle/123456789/15386

Wilanda Nata Karya, A. S. (2019). Pengaruh Penggunaan Metode Problem Solving Strategi Polya Terhadap Hasil Belajar Soal Cerita di Sekolah Dasar. *E-Jurnal Inovasi Pembelajaran*, *8*, 182–195.

Wirawan, I. W. A., Sariyasa, & Ardana, I. M. (2019). Pengaruh penerapan model pembelajaran peningkatan kemampuan berpikir terhadap kemampuan pemecahan masalah matematika siswa kelas VIII SMP negeri 2 Sawan. *Jurnal Pendidikan Dan*

Pembelajaran Matematika Indonesia, 7(2), 121–130.

Yani, M. (2018). *Pengaruh Strategi Heuristik Strategi Polya Terhadap Kemampuan Pemecahan masalah matematika Siswa Pada Pokok Bahasan Lingkaran di Kelas VII SMP IT Al Husnayain Panyabungan*. Institut Agama Islam Negeri Padang Simpuan.