Kontinu: Jurnal Penelitian Didaktik Matematika
E-ISSN: 2656-5544
P-ISSN: 2715-7326
Vol. 9, No. 1: May 2025
Hal. 58 - 75

Cooperative Learning Models and the Improvement of Mathematical Problem Solving Skills: Key Findings from a Meta-Analysis Study

Maulana Eka Pratikta[1)*], Caswita[2)], Rangga Firdaus[3)]

Master of Mathematics Education, University of Lampung, Indonesia[1,2,3)]
*Corresponding e-mail: maulanaprime@gmail.com

Abstract. *This study aims to evaluate the extent to which cooperative learning models influence the improvement of students' mathematical problem-solving skills. This research employed a meta-analysis method by analyzing 22 primary studies published in nationally accredited journals between 2018 and 2024. The selected studies, obtained through Google Scholar, involved subjects from junior high schools, senior high schools, vocational schools, and higher education. Data were analyzed using the Comprehensive Meta-Analysis (CMA) software, following procedures such as calculating effect sizes, testing for heterogeneity, selecting an appropriate estimation model, and detecting publication bias. The analysis revealed an overall effect size of 1.242, which is categorized as strong. These findings indicate that implementing cooperative learning models significantly positively impacts students' mathematical problem-solving abilities.*

Keywords: *Cooperative Learning, Mathematical Problem-solving, Meta-analysis*

INTRODUCTION

The learning process continues to evolve, including significant changes in assessing student learning achievement in the 21st century. According to (Muhali, 2019), modern learning assessment focuses on material mastery and measures students' knowledge competencies, intrapersonal abilities, and interpersonal skills. Knowledge competency involves understanding and applying learning concepts, while intrapersonal ability relates to problem-solving skills, creativity, and self-confidence. On the other hand, interpersonal skills focus on communicating and cooperating with others. This comprehensive approach to assessment aims to prepare students to become academically intelligent individuals with strong life skills.

In the context of mathematics learning, problem-solving ability is an essential competency that students must possess. However, in practice, the fulfilment of this competency often encounters obstacles. Many teachers consider problem-solving skills difficult, while students struggle to understand and solve contextual problems. Research by Joefanny et al. (2021) shows that students struggle to understand basic concepts, choose the right solution strategy, and interpret problems systematically. This difficulty is exacerbated by the lack of understanding of mathematical concepts and the limited ability of students to analyze problems thoroughly. In addition, Pebrianti et al. (2023) revealed that students with low initial mathematics ability tend to struggle to understand concepts and link between concepts in the problem-solving process. It shows that problem-solving in mathematics involves solving routine problems and representation, modelling, and deep thinking strategies.

This problem is increasingly complex, considering that problem-solving in mathematics involves solving routine problems and representation, modelling, and deep thinking strategies (Hidayat & Sariningsih, 2018). Proper representation is important because it can help students identify important information and choose effective solution methods (Fatah & Risfina, 2023). For this reason, a learning strategy is needed to accommodate students' needs in developing higher-order thinking skills.

Previous research has examined many effective learning models, including the Cooperative Learning Model. This model allows students to discuss, share ideas, and learn from each other directly, thus not only improving cognitive but also social skills (Febriyanti et al., 2019). In addition, Nugroho and Dwijayanti (2019) emphasize the importance of using approaches that involve students actively in the problem-solving process, such as problem-based models that follow Polya's stages: understanding the problem, planning the strategy, implementing the strategy, and reviewing the solution.

However, although many studies have shown the effectiveness of Cooperative Learning Models on mathematical problem-solving skills, these results still vary depending on the type of model, level of education, and research design used. The research gap, namely the absence of a quantitative synthesis that comprehensively summarizes how much real influence cooperative learning models have on students' mathematical problem-solving skills. The study offers a

Kontinu: Jurnal Penelitian Didaktik Matematika
E-ISSN: 2656-5544
P-ISSN: 2715-7326
Vol. 9, No. 1: May 2025
Hal. 58 - 75

solution through a meta-analysis approach, intending to integrate previous research results statistically. Meta-analysis gives more power to draw more generalizable conclusions than reviewing individual studies. In addition, the results of this meta-analysis are important to provide a strong empirical foundation for teachers, researchers, and education policymakers in designing more effective and evidence-based mathematics learning strategies.

Study Objective

This study aims to evaluate the effectiveness of cooperative learning models in improving students' mathematical problem-solving skills through a meta-analysis approach. Specifically, this study aims to:

1. Analyzing the effect size of the application of the cooperative learning model;
2. Evaluate the statistical significance of the model's effect on mathematical problem-solving ability.

Research Question

This study was designed to answer the following questions:

1. How significant is the effect of the cooperative learning model on students' mathematical problem-solving ability?
2. Is the effect statistically significant compared to the conventional learning method?

Scope

The scope of the review includes 22 research articles published in accredited national journals (Sinta 1-5) between 2018 and 2025 and obtained through a search on Google Scholar. The studies analyzed were quantitative research with an experimental design, where a cooperative learning model was applied to at least one experimental class. Only articles that included quantitative data, such as sample size, mean, and standard deviation, were used. This study did not include qualitative studies, non-experimental descriptive studies, or articles that did not meet the statistical criteria for meta-analysis.

Study Contribution

This review makes an important contribution to the mathematics education literature by presenting the latest quantitative evidence on the effectiveness of Cooperative Learning Models. This meta-analysis's findings bring together previous studies' results and provide data-driven guidance to teachers, researchers, and policymakers in developing learning strategies that can significantly improve students' problem-solving skills. As such, this review helps fill the gaps in the existing literature and enrich conceptual and practical understanding of mathematics pedagogy.

RESEARCH METHODS

This research uses the meta-analysis method, a statistical approach used to systematically and objectively combine and analyze the results of several primary studies systematically and objectively. This meta-analysis aims to evaluate the effectiveness or influence of cooperative learning models on improving students' mathematical problem-solving skills. The analysis procedure follows the steps developed by Borenstein et al. (2021), which include (a) calculating the effect size of each primary study, (b) conducting heterogeneity tests and selecting an appropriate estimation model, (c) checking for potential publication bias, and (d) calculating p-values to test the research hypotheses. The analysis was conducted with the help of Comprehensive Meta-Analysis (CMA) software.

This study analyzed 22 experimental research articles published in accredited national journals (Sinta 1 to Sinta 5) between 2018 and 2025. The articles were obtained through a search on Google Scholar with the keywords "Cooperative Learning" and "Mathematical Problem Solving." The selection of Google Scholar as a search source was based on its ability to provide broad and rapid access to scientific literature from various disciplines. Google Scholar allows researchers to find journal articles, conference papers, and scholarly books without subscribing to a specific database. Khairiyah and Marlini (2022) also showed that Google Scholar is very helpful for students in meeting their research information needs. Articles were selected based on the inclusion criteria, namely: (1) published in an accredited national journal, (2) included at least one experimental class treated with a cooperative learning model, and (3) included statistical data such as sample size, mean score, and standard deviation. Meanwhile, articles that did not meet the validation criteria or were irrelevant to the research focus were excluded from the analysis (Kholili et al., 2021).

The use of effect size in this analysis aims to measure the strength of each study's influence on the variables studied and compare them objectively. The data that has been collected is analyzed using the effect size formula submitted by Glass (in Kholili et al. 2021), as follows:

$$ES = \frac{\overline{X_e} - \overline{X_c}}{Spooled}$$

Description:

ES	: effect size
$\overline{X_e}$	: average score of the experimental group
$\overline{X_c}$	: control group mean score
$Spooled$	: pooled standard deviation

Considering the variation in sample size between studies, this study used Hedge's g equation to determine the effect size index (Cohen, 2013). Interpretation of effect size using Cohen's guidelines, namely:

Table 1. Effect Size Catagory

No	*Effect Size*	Category
1	$ES < 0,2$	Ignored
2	$0,2 \leq ES < 0,5$	Weak effect
3	$0,5 \leq ES < 0,8$	Medium effect
4	$0,8 \leq ES < 1,3$	Strong effect
5	$\mathrm{ES} \geq 1,3$	Powerful effect

After calculating the effect sizes, the next step is to perform a homogeneity test by examining the Q statistic and the p-value. If the p-value < 0.05 indicates that the effect size distribution of the primary study is heterogeneous, the analysis model used is a random effects model. Conversely, if the p-value > 0.05, the effect size distribution is considered homogeneous, and a fixed effects model is used (Tamur et al., 2020). A between-study variability analysis examined moderator variables after determining the random effects model as the chosen estimation (Naibaho & Hoesein, 2021). Publication bias was examined to prevent misinterpretation of the findings. Published studies are more likely to be included in meta-analyses than unpublished ones, so there is a concern that meta-analysis results could overestimate the actual effect size (Borenstein et al., 2021). The robustness of effect size data to publication bias was examined using funnel plots. Studies were considered bias-free if effects were symmetrically spread around a vertical line (Anjarwati et al., 2022). If the effects are not symmetrically distributed, a File-Safe N (FSN) test is performed to determine the possibility of publication bias (Gleser & Olkin, 1996). Without publication bias, the analysis can proceed with the predefined model. If the p-value <0.05, then the null hypothesis is accepted, i.e., the application of the cooperative learning model significantly affects students' mathematical problem-solving ability.

RESULTS AND DISCUSSION

Based on search results through Google Scholar and screening with inclusion and exclusion criteria, 22 research articles were obtained that were eligible for analysis. These articles were screened based on statistical data completeness, topic suitability, and publication validity. The studies were spread across junior high school (JHS), senior high school (SHS), vocational school (VS), and higher education (HE), and all used cooperative learning models as the intervention. Details of the articles are shown in Table 2.

Table 2. Studies used in the meta-analysis

Study Code	Author/Year	Goals	Methods	Subject	Results
1	(Marfungah et al., 2020)	Effect of Cooperative Script and CIRC	Quasi-experiment	JHS students	CIRC is more effective
2	(Siregar, 2021)	STAD skill improvement	Quasi-experiment	JHS students	STAD is effective
3	(Hidayah & Mira Bella Saragih, 2020)	Effect of TGT	Quasi-experiment	SHS students	TGT has an effect
4	(Siregar & Khayroiyah, 2019)	Effect of Jigsaw	Quasi-experiment	HE Students	Jigsaw has an effect
5	(Wahid et al., 2022)	TTW Effect	Quasi-experiment	JHS students	TTW is effective
6	(Jumrah, 2023)	TPS Effectiveness	PTK	SHS students	TPS is effective
7	(Rahman, 2020)	Effect of CIRC	Quasi-experiment	Vocational Students	CIRC medium effect

8	(Siwa et al., 2018)	Jigsaw vs STAD	Comparative	SHS students	Jigsaw is more effective
9	(Salim et al., 2024)	Effectiveness of CIRC	Quasi-experiment	JHS students	CIRC is effective
10	(Tampubolon & Sitompul, 2022)	Effectiveness of STAD	Pre-experimental	SHS students	STAD is effective
11	(Nurmahwati & Rahmawati, 2020)	Co-op Co-op Effect	Quasi-experiment	JHS students	Co-op Co-op is very effective
12	(Utami & Mulyani, 2019)	TPS Effectiveness	Quasi-experiment	JHS students	TPS is effective
13	(Sinaga et al., 2021)	Effect of NHT	Quasi-experiment	JHS students	NHT has an effect
14	(Jumaisyaroh et al., 2019)	STAD Effect	Quasi-experiment	JHS students	STAD improves the ability of
15	(Fatmawati & idayatuloh, 2021)	TPS influence	Quantitative survey	MTs Students	TPS has a significant effect (27.25%)
16	(Sunita et al., 2021)	Effect of NHT	Quasi-experiment	JHS students	NHT is effective for problem solving
17	(Sih Dewanti, 2018)	PBL + TPS for problem-solving	Quasi-experiment	JHS students	PBL + TPS is effective
18	(Kusumaningrum & Manoy, 2019)	Effect of Jigsaw	Quasi-experiment	JHS students	Jigsaw has a positive effect
19	(Sari & Saputri, 2018)	Effect of Jigsaw	Quasi-experiment	JHS students	Jigsaw is more effective than direct learning
20	(Wahyuni et al., 2025)	STAD Effect	Quasi-experiment	JHS students	STAD is better than the conventional method
21	(Wahid et al., 2022)	The Influence of Think Talk Write	Quasi-experiment	JHS students	Think Talk Write improves problem-solving skills
22	(Febrian et al., 2024)	Effect of Geogebra-assisted CPS	Quasi-experiment	MTs Students	CPS is highly effective (high effect size)

The main objective of this meta-analysis study was to determine the overall effect of Cooperative Learning Models on students' mathematical problem-solving skills. The first stage of the analysis was to calculate the effect size of each primary study. Based on the overall calculation, the effect sizes of each study are presented in Table 3.

Tabel 3. Transformasi Effect Size dan Standard Error

Study Code	**Level**	**Effect Size (SE)**	**Effect Size Category**	**Standard Error**
Study 1	JHS	0,29	Weak effect	0,28
Study 2	JHS	1,58	Very strong effect	0,29
Study 3	SHS	2,84	Very strong effect	0,34
Study 4	HE	1,91	Very strong effect	0,30
Study 5	JHS	0,49	Moderate effect	0,31
Study 6	SHS	0,50	Moderate effect	0,25
Study 7	VS	0,50	Moderate effect	0,25
Study 8	SHS	1,31	Very strong effect	0,31
Study 9	JHS	0,85	Strong effect	0,26
Study 10	SHS	2,04	Very strong effect	0,39
Study 11	JHS	1,17	Strong effect	0,27
Study 12	JHS	0,19	Negligible effect	0,22
Study 13	JHS	0,24	Weak effect	0,25
Study 14	JHS	3,27	Very strong effect	0,39
Study 15	MTs	1,80	Very strong effect	0,31
Study 16	JHS	0,85	Very strong effect	0,26
Study 17	JHS	0,63	Moderate effect	0,27
Study 18	JHS	0,47	Moderate effect	0,27
Study 19	JHS	0,65	Moderate effect	0,26
Study 20	JHS	0,68	Moderate effect	0,27
Study 21	JHS	0,82	Very strong effect	0,26
Study 22	MTs	1,10	Very strong effect	0,20

Table 3 shows that the selected literature studies' overall range of effect sizes is between 0.19 and 3.27, with a 95% confidence level. From these results, it was found that there were 10 studies with a very strong effect size category, two studies with strong effect category, nine studies with a moderate effect category, two studies with a weak effect category, and 1 study with a negligible effect category.

Kontinu: Jurnal Penelitian Didaktik Matematika
E-ISSN: 2656-5544
P-ISSN: 2715-7326
Vol. 9, No. 1: May 2025
Hal. 58 - 75

Furthermore, the meta-analysis results of the selected literature studies will be presented using the fixed and random effect models in Table 4.

Table 4. Effect Size Transformation for Each Study

Estimation Model	n	Z	p	Effect Size	Std. Error	95% CL		Q_b	P-value	I-Squared
						Lower Limit	Upper Limit			
Fixed Effect	22	16.441	0,000	0.933	0.057	0.822	1.045	141.296	0,000	84.43 %
Random Effect	22	7.248	0,000	1.051	0.145	0.767	1.335			

Table 4 compares the meta-analysis results based on the fixed and random-effects models. Based on the results in Table 4, in the fixed effects model, the lower limit of the 95% confidence interval is 0.822, and the upper limit is 1.045, with an overall effect size of 0.933. According to Cohen's effect size category, this value falls into the medium to strong effect size category. The next step is to conduct a heterogeneity test and select an appropriate estimation model.

From Table 4, we obtained a Qb value of 141.296 with a p-value of 0.000. This result indicates that the distribution of effect sizes is heterogeneous as $p < 0.05$, meaning there is a significant variation between studies. In addition, the I-squared value of 84.43% indicates that 84.43% of the observed effect size variability is due to apparent heterogeneity between studies rather than sampling error. This value indicates a high level of heterogeneity (as I-squared ≥ 75%).

Therefore, following the heterogeneity test results, which showed a significant difference between studies, the appropriate estimation model is the random effects model. The random effects model obtained an overall effect size of 1.051 with a 95% confidence interval between 0.767 and 1.335. This result

Kontinu: Jurnal Penelitian Didaktik Matematika
E-ISSN: 2656-5544
P-ISSN: 2715-7326
Vol. 9, No. 1: May 2025
Hal. 58 - 75

indicates that the cooperative learning model significantly and strongly influences improving students' mathematical problem-solving ability.

The next step is to check for publication bias, as seen from the funnel plot in Figure 1.

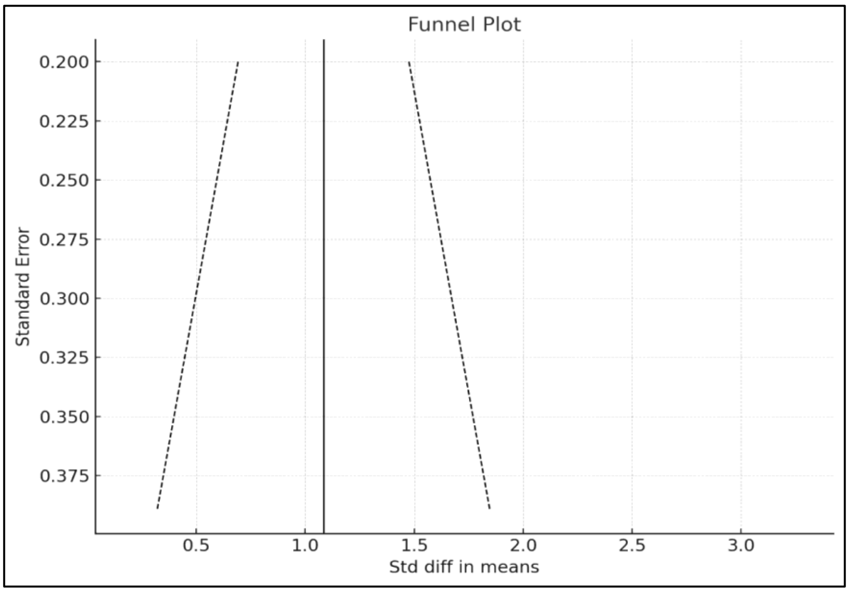

Figure 1. Funnel Plot

Based on Figure 1, it can be seen that the spread of the effect size is not entirely symmetrical around the vertical line. Therefore, the value of the Fail-safe (FSN) statistic needs to be checked. Based on CMA calculations, the results of Orwin's fail-safe N are shown in Figure 2.

Orwin's fail-safe N	
Std diff in means in observed studies	1.08391
Criterion for a 'trivial' std diff in means	0.00000
Mean std diff in means in missing studies	0.00000

Figure 2. Orwin's Fail-Safe N

Based on the results of Orwin's Fail-Safe N, Std.diff = 1.08391 > 1. This result indicates that the studies selected in this analysis resist publication bias. Thus, no studies are missing or need to be added to the analysis due to publication bias.

The final stage in this meta-analysis research is to calculate the p-value to test the research hypothesis. The results presented in Table 4 compare the analysis results based on the estimation model. Table 4 shows that according to the random-effects model with a 95% confidence interval, the range is between 0.767 and 1.335, which means the mean difference of the analyzed studies can be anywhere within this interval. In addition, the overall effect size of the studies was 1.051, which falls into the strong effect size category. Furthermore, the z-test calculation results showed a value of $z = 7.248$. This result is statistically significant at the $p < 0.001$ level. Thus, it can be concluded that applying the cooperative learning model influences students' mathematical problem-solving ability.

The findings in this study show that cooperative learning models significantly improve mathematical problem-solving skills, which aligns with the results of a recent meta-analysis. For example, Arifah et al. (2025) found that the STAD-type cooperative learning model significantly affects students' mathematics learning outcomes, with an effect size value of 1.38, which is included in the vast effect category. In addition, Amin et al. (2020) reported that the cooperative learning model improved mathematics learning achievement with an effect size value of 0.73 (medium effect category). Interestingly, the Talking Stick type shows the most significant influence with an effect size of 1.06 (large effect category). Another study, according to Ridwan et al. (2022), in their meta-analysis study on vocational students, found that the cooperative learning model provides a moderate effect on mathematics learning outcomes, with an effect size value of 0.89. The effectiveness of this model was higher in grade 11 students than in grade 10, as well as in classes with the number of students 1-30 compared to larger classes.

These findings strengthen the results of this study, showing that cooperative learning models effectively improve mathematical problem-solving skills at various levels of education and types of learning. The consistency of these findings can be explained by the characteristics of cooperative learning models that encourage students' active involvement in the learning process. This model creates a collaborative learning environment, facilitates the exchange of ideas, and strengthens concept understanding through group discussions. As shown by Arifah et al. (2025), the high effectiveness of the STAD model occurs due to the heterogeneous group structure and individual responsibility in group achievement. Meanwhile, the results of Amin et al. (2020), which highlighted Talking Stick, indicated the importance of active engagement and communication rotation in improving critical thinking skills. Ridwan et al. (2022) found that the effectiveness of cooperative learning is more optimal in small groups, which is in line with Vygotsky's theory on the importance of social interaction in cognitive development. Thus, this study's findings align with the basic principle of social-constructivist learning that places student interaction as the key to successful problem-solving-based mathematics learning.

CONCLUSION

A meta-analysis of 22 studies on the application of cooperative learning models found that this model strongly influences students' mathematical problem-solving skills. The statistical analysis showed an overall effect size of 1.051, which falls into the strong effect size category.

The cooperative learning model proved more effective than conventional learning in improving mathematical problem-solving skills. This finding reinforces the importance of cooperative strategies in mathematics learning, especially to encourage students' active involvement, collaboration, and critical thinking skills.

As an implication, teachers and educational policymakers are advised to adopt cooperative learning models more widely in mathematics teaching practices. In addition, further research should be conducted to explore other moderating factors, such as the type of mathematics task, learners' background, and implementation duration, to optimize the effectiveness of cooperative learning in various contexts.

REFERENCES

Amin, M. K., Isnani, I., & Paridjo, P. (2020). Meta Analisis Pengaruh Cooperative Learning terhadap Prestasi Belajar Matematika. *PRISMA*, *9*(2), 221–233. https://doi.org/10.35194/jp.v9i2.1072

Anjarwati, D., Juandi, D., Nurlaelah, E., & Hasanah, A. (2022). Studi Meta-

Analisis: Pengaruh Model Discovery Learning Berbantuan Geogebra Terhadap Kemampuan Berpikir Kritis Matematis Siswa. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *6*(3), 2417–2427. https://doi.org/10.31004/cendekia.v6i3.1506

Arifah, D. N., Katminingsih, Y., & Widodo, S. (2025). Meta-Analysis: The Effect of STAD Type Cooperative Learning Model on Students' Mathematics Learning Outcomes. *International Journal of Research and Review [Indexed, Peer Reviewed Journal*, *12*. https://doi.org/10.52403/ijrr.20250116

Borenstein, M., Hedges, L. V. ., Higgins, J. P. T. ., & Rothstein, H. (2021). *Introduction to meta-analysis*. John Wiley & Sons, Inc. https://books.google.com/books/about/Introduction_to_Meta_Analysis.html?hl=id&id=pdQnEAAAQBAJ

Cohen, J. (2013). Statistical Power Analysis for the Behavioral Sciences. In *Statistical Power Analysis for the Behavioral Sciences*. Routledge. https://doi.org/10.4324/9780203771587

Fatah, A. H., & Risfina, A. M. (2023). Teori Pemrosesan Informasi dan Implikasinya Dalam Pembelajaran. *Jurnal Ilmiah Mandala Education*, *9*(3), 1632–1641. https://doi.org/10.58258/jime.v9i3.5256

Fatmawati, F. (Fatmawati), & idayatuloh, I. (idayatuloh). (2021). Pengaruh Model Pembelajaran Kooperatif Tipe Think Pair Share terhadap Kemampuan Pemecahan Masalah Matematika. *Tulisan Ilmiah Pendidikan*, *10*(1), 13–26. https://doi.org/10.54438/TULIP.V10I1.180

Febrian, M. Z., Hayati, L., Junaidi, & Amrullah. (2024). Pengaruh Model Pembelajaran Creative Problem Solving (CPS) Berbantuan Geogebra Terhadap Kemampuan Pemecahan Masalah Siswa. *Pendas : Jurnal Ilmiah Pendidikan Dasar*, *9*(2), 955–966. https://doi.org/10.23969/JP.V9I2.17079

Febriyanti, F., Bagaskorowati, R., & Makmuri, M. (2019). The Effect of The Realistic Mathematics Education (RME) Approach and The Initial Ability of Students on The Ability of Student Mathematical Connection. *International Journal for Educational and Vocational Studies*, *1*(3), 153–156. https://doi.org/10.29103/ijevs.v1i3.2117

Gleser, L. J., & Olkin, I. (1996). Models For Estimating The Number Of Unpublished Studies. *Statistics in Medicine*, *15*(23), 2493–2507. https://doi.org/10.1002/(SICI)1097-0258(19961215)15:23<2493::AID-SIM381>3.0.CO;2-C

Hidayah, N., & Mira Bella Saragih, R. (2020). Pengaruh Model Pembelajaran Kooperatif Tipe Teams Games Tournament (TGT) Terhadap Kemampuan Pemahaman Konsep Dan Pemecahan Masalah Matematik Siswa. *Journal of Maritime and Education (JME)*, *2*(2), 150–154. https://doi.org/10.54196/JME

Hidayat, W., & Sariningsih, R. (2018). Kemampuan Pemecahan Masalah Matematis Dan Adversity Quotient Siswa Smp Melalui Pembelajaran Open Ended. *Jurnal JNPM (Jurnal Nasional Pendidikan Matematika)*, *2*(1), 109. https://doi.org/10.33603/jnpm.v2i1.1027

Joefanny, L., Annas, M. K., Pratama, M. A., & Fauzi, A. (2021). Analisis Kesulitan Siswa dalam Memahami Konsep Matematika di Sekolah Menengah Pertama. *Jurnal Pendidikan Matematika*, *15*(1), 14–27. https://doi.org/10.62775/edukasia.v5i1.1179

Jumaisyaroh, T., Pengaruh, S. :, Kooperatif, P., Stad, T., Peningkatan, T., Pemecahan, K., Matematis, M., & Smp, S. (2019). Pengaruh Pembelajaran Kooperatif Tipe Stad Terhadap Peningkatan Kemampuan Pemecahan Masalah Matematis Siswa SMP. *AXIOM : Jurnal Pendidikan Dan Matematika*, *8*(1). https://doi.org/10.30821/AXIOM.V8I1.5454

Jumrah, J. (2023). Meningkatkan Efektivitas Pembelajaran Matematika Melalui Penggunaan Model Kooperatif Tipe Think-Pair-Share (TPS). *Griya Journal of Mathematics Education and Application*, *3*(1), 141–158. https://doi.org/10.29303/GRIYA.V3I1.292

Khairiyah, W., & Marlini. (2022). Pemanfaatan google scholar dalam pemenuhan kebutuhan informasi penelitian mahasiswa prodi perpustakaan dan ilmu informasi Universitas Negeri Padang. *Nautical : Jurnal Ilmiah Multidisiplin*, *1*(9), 1058–1072. https://doi.org/10.55904/nautical.v1i12.525

Kholili, A., Shoffa, S., & Soemantri, S. (2021). Pembelajaran Matematika Model Discovery Learning Terhadap Kemampuan Berpikir Kreatif Siswa: Kajian

Meta Analisis. *JPMI: Jurnal Pembelajaran Matematika Inovatif*, *4*(6), 1441–1452. https://doi.org/10.22460/jpmi.v4i6.1441-1452

Kusumaningrum, S. Y., & Manoy, J. T. (2019). Pengaruh Model Pembelajaran Kooperatif Tipe Jigsaw Terhadap Kemampuan Pemecahan Masalah Matematika. *MATHEdunesa*, *8*(2), 106–109. https://doi.org/10.26740/MATHEDUNESA.V8N2.P106-109

Marfungah, A., Nugraheni, P., & Yuzianah, D. (2020). P Pengaruh Model Pembelajaran Cooperative Script dan Circ Dalam Kemampuan Pemecahan Masalah Ditinjau Dari Gaya Kognitif. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *4*(2), 779–786. https://doi.org/10.31004/cendekia.v4i2.288

Muhali, M. (2019). Pembelajaran Inovatif Abad Ke-21. *Jurnal Penelitian Dan Pengkajian Ilmu Pendidikan: E-Saintika*, *3*(2), 25. https://doi.org/10.36312/e-saintika.v3i2.126

Naibaho, M. R. U., & Hoesein, E. R. (2021). Meta Analisis Model Discovery Learning Untuk Meningkatkan Hasil Belajar IPA Siswa SD. *JPDI (Jurnal Pendidikan Dasar Indonesia)*, *6*(1), 19. https://doi.org/10.26737/jpdi.v6i1.2290

Nugroho, A. A., & Dwijayanti, I. (2019). Analisis Kemampuan Pemecahan Masalah Mahasiswa Calon Guru Matematika Pada Mata Kuliah Program Linier. *AKSIOMA : Jurnal Matematika Dan Pendidikan Matematika*, *10*(2), 277–284. https://doi.org/10.26877/aks.v10i2.4720

Nurmahwati, N., & Rahmawati, R. (2020). Pengaruh Model Pembelajaran Kooperatif Tipe CO-OP CO-OP terhadap Kemampuan Pemecahan Masalah Statistika Peserta Didik Kelas VIII SMP Negeri 1 Minasate'ne Kab. Pangkep. *EQUALS: Jurnal Ilmiah Pendidikan Matematika*, *3*(1), 41–49. https://doi.org/10.46918/EQ.V3I1.575

Pebrianti, A., Usdiyana, D., Dedy, E., & Sudihartinih, E. (2023). Kesulitan Siswa Dalam Menyelesaikan Soal Pemecahan Masalah Ditinjau Dari Kemampuan Awal Matematika Siswa. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *12*(3), 3530. https://doi.org/10.24127/ajpm.v12i3.7400

Rahman, A. (2020). Pengaruh Model Pembelajaran Cooperative Integrated

Reading And Composition (CIRC) Terhadap Peningkatan Kemampuan Pemahaman Matematis Siswa SMK. *Educatif Journal of Education Research*, *2*(4), 109–115. https://doi.org/10.36654/EDUCATIF.V2I4.174

Ridwan, M. R., Hadi, S., & Jailani, J. (2022). A meta-analysis study on the effectiveness of a cooperative learning model on vocational high school students' mathematics learning outcomes. *Participatory Educational Research*, *9*(4), 396–421. https://doi.org/10.17275/per.22.97.9.4

Salim, E., Putri Utami, N., Matematika, T., Tarbiyah dan Keguruan, F., & Imam Bonjol Padang, U. (2024). Efektivitas Model Pembelajaran Cooperative Integrad Reading And Composition Terhadap Kemampuan Pemecahan Masalah Matematis. *Math Educa Journal*, *8*(1), 141–153. https://doi.org/10.15548/MEJ.V8I1.8344

Sari, D. P., & Saputri, L. (2018). Pengaruh Model Pembalajaran Kooperatif Tipa Jigsaw Terhadap Kemampuan Pemecahan Masalah Matematika Siswa SMP Swasta Swadaya Batang Serangan. *Jurnal MathEducation Nusantara*, *1*(2), 108–115. https://doi.org/10.54314/JMN.V1I2.41

Sih Dewanti, S. (2018). Pengaruh Penerapan Pendekatan Problem Based Learning (PBL) Dengan Model Pembelajaran Kooperatif Tipe Think Pair Share (TPS) Terhadap Peningkatan Kemampuan Pemecahan Masalah Matematika Dan Self Confidence. *AdMathEdu : Jurnal Ilmiah Pendidikan Matematika, Ilmu Matematika Dan Matematika Terapan*, *8*(1), 59–74. https://doi.org/10.12928/ADMATHEDU.V8I1.11120

Sinaga, R. S., Sitepu, D. R., & Stkip Budidaya, D. (2021). Pengaruh Model Pembelajaran Kooperatif Tipe Numbered Heads Together (NHT) Terhadap Pemecahan Masalah Matematis Siswakelas VIII SMP Negeri 2 Stabat. *Serunai : Jurnal Ilmiah Ilmu Pendidikan*, *7*(2), 152–160. https://doi.org/10.37755/SJIP.V7I2.511

Siregar, T. J. (2021). Peningkatan Kemampuan Pemecahan Masalah Matematis Dan Keterampilan Sosial Siswa Smp Melalui Pembelajaran Kooperatif Tipe STAD. *AXIOM : Jurnal Pendidikan Dan Matematika*, *10*(1), 97–109. https://doi.org/10.30821/AXIOM.V10I1.9265

Siregar, T. J., & Khayroiyah, S. (2019). Pengaruh Model Pembelajaran Kooperatif Tipe Jigsaw terhadap Kemampuan Pemecahan Masalah Matematis Mahasiswa. *Jurnal MathEducation Nusantara*, *2*(2), 150–154. https://doi.org/10.54314/JMN.V2I2.85

Siwa, L. A. R., Safitri, I., & Pasaribu, L. H. (2018). Perbandingan Model Pembelajaran Kooperatif Tipe Jigsaw Dengan STAD (Student Team Achievement Division) Terhadap Kemampuan Pemecahan Masalah Matematika Siswa Kelas Xi SMA Muhammadiyah 10 Rantauprapat. *JURNAL PEMBELAJARAN DAN MATEMATIKA SIGMA (JPMS)*, *4*(2), 17–26. https://doi.org/10.36987/JPMS.V4I2.1256

Sunita, N. wayan, Erawati, N. K., Parmithi, N. N., & Purnamawati, N. P. W. (2021). Pengaruh Model Pembelajaran Kooperatif Tipe Numbered Head Together Terhadap Kemampuan Pemecahan Masalah Matematis Dengan Mengontrol Kecerdasan Emosional. *Emasains : Jurnal Edukasi Matematika Dan Sains*, *10*(1), 1–78. https://doi.org/10.5281/ZENODO.4657663

Tampubolon, T. T., & Sitompul, P. (2022). Efektivitas Model Pembelajaran Kooperatif Tipe Student Teams Achievement Divisions (STAD) Terhadap Kemampuan Pemecahan Masalah Matematika Siswa Di Kelas X IPA SMA Negeri 1 Sipahutar Tahun Ajaran 2021/2022. *Humantech: Jurnal Ilmiah Multidisiplin Indonesia*, *1*(10), 1339–1355. https://doi.org/10.32670/ht.v1i10.2147

Tamur, M., Juandi, D., & Adem, A. M. G. (2020). Realistic Mathematics Education in Indonesia and Recommendations for Future Implementation: A Meta-Analysis Study. *JTAM | Jurnal Teori Dan Aplikasi Matematika*, *4*(1), 17. https://doi.org/10.31764/jtam.v4i1.1786

Utami, T., & Mulyani, M. (2019). Keefektifan Model Pembelajaran Kooperatif Tipe Think Pair And Share (TPS) Terhadap Kemampuan Pemecahan Masalah Matematika Peserta Didik Kelas Vii Pada Materi Segitiga Di MTs Negeri Salatiga Tahun Ajaran 2018/2019. *Hipotenusa : Journal of Mathematical Society*, *1*(1), 33–39. https://doi.org/10.18326/HIPOTENUSA.V1I1.33-39

Wahid, R., Busnawir, & Sahidin, L. (2022). Pengaruh Model Pembelajaran

Kooperatif Tipe Think Talk Write Terhadap Kemampuan Pemecahan Masalah Matematis Siswa. *Jurnal Amal Pendidikan*, *3*(3), 223–233. https://doi.org/10.36709/JAPEND.V3I3.19

Wahyuni, D., Wahniati, E., dan Bisnis, E., Dharmawangsa, U., Negeri Rantauprapat, M., & Gelugur, P. (2025). Dampak Model Pembelajaran Kooperatif Tipe STAD terhadap Peningkatan Kemampuan Pemecahan Masalah Matematis Siswa. *Warta Dharmawangsa*, *19*(1), 673–688. https://doi.org/10.46576/WDW.V19I1.6067