PROSPECT Vol 1 No 1 (2025) 9-20

PROSPECT

p-ISSN: xxxx-xxxx (print), e-ISSN: xxxx-xxxx (online)
https://journal.solusiriset.com/index.php/prospect

A cooperative learning approach to strengthen mathematical critical thinking: The find match in group model

Diah Sriwahyuni[1], Andika Eko Prasetiyo[2]

[1] SDIT Atikah Musaddad Garut, Indonesia
[2] Graduate school of humanities and social sciences, University of Melbourne, Australia

ARTICLE INFO

Article History
Revised : 02-02-2025
Accepted : 15-04-2025
Available Online : 30-06-2025

Keywords:
Critical Thinking; Elementary School Students; Find Match in Group.

*Correspondence: E-mail:
diahsriyuni@gmail.com

Doi:
10.55749/prospect.v1i1.138

ABSTRACT

This study aims to examine the improvement of elementary students' mathematical critical thinking skills through the Find Match in Group learning model. This quasi-experimental research employed a pretest–posttest design involving 30 students in the experimental group and 31 students in the control group at SDN Leuwinutug 04. The experimental group received instruction using the Find Match in Group model, while the control group received conventional learning. Data were collected through pretest and posttest instruments on cube and cuboid volume topics. Results revealed no significant difference between the pretest scores of both groups, indicating comparable initial abilities. Posttest results, however, demonstrated significant differences, with the experimental group achieving higher gains. N-gain analysis further confirmed that the improvement in the experimental group was significantly greater than that in the control group. These findings indicate that the Find Match in Group model effectively enhances students' mathematical critical thinking skills.

https://journal.solusiriset.com/index.php/prospect

INTRODUCTION

Critical thinking is widely recognized as a core competence in modern mathematics education, emphasized in the 2013 Curriculum as a foundation for developing students' analytical, logical, and evaluative abilities (Kemendikbud, 2016). Despite this mandate, students in Indonesia continue to demonstrate low performance in tasks requiring higher-order thinking (Munifah et al, 2019a; Sumarni et al, 2019a; Sumarni et al, 2019b; Huda et al, 2019). The PISA 2018 report places Indonesia at rank 72 out of 78 participating countries, with most students struggling to interpret information, analyze problems, and apply reasoning strategies effectively (OECD, 2019). These findings are consistent with national studies showing persistent difficulties in conceptual understanding, representational fluency, and analytical reasoning among elementary students (Irawan & Kencanawaty, 2017; Kartimi et al., 2012).

One major factor contributing to these challenges is the persistence of teacher-centered instructional practices, where learning activities prioritize procedural execution over inquiry, exploration, and justification (Widayanti, 2019). Research in mathematics education underscores that developing critical thinking requires learning environments that allow students to articulate ideas, evaluate alternatives, solve open-ended problems (Diani et al, 2019; Munifah et al, 2019b; Huda et al, 2020a; Huda et al, 2020b), and collaborate meaningfully conditions particularly important in elementary settings (Ariana, 2016; Sleman, 2022). Recent empirical studies further confirm that interactive, inquiry-oriented teaching approaches such as Problem-Based Learning and collaborative problem solving result in significantly higher gains in critical thinking than conventional instruction (Setyaningsih & Abadi, 2024; Yuliyanti & Rahayu, 2021).

Although various cooperative learning models have been shown to improve engagement and achievement, studies specifically examining their impact on mathematical critical thinking skills especially at the elementary level remain limited. Existing literature tends to focus on outcomes such as motivation, participation, or general academic performance rather than deeper cognitive processes such as analysis, justification, and inference (Yasin et al, 2020; Sunyono et al, 2022). Even models like Group Investigation and Make a Match, while beneficial, still show weaknesses in individual accountability and depth of reasoning (Ariana, 2016). More recent studies also highlight that elementary students require structured collaborative scaffolds to optimize reasoning, as seen in research on Collaborative Learning and TPS-based cooperative structures (Rosidah et al., 2022; Yani et al., 2023; Sejati & Widjajanti, 2024).

The Find Match in Group model, which integrates structured reasoning tasks with investigation and card-matching activities requiring justification and explanation, has conceptual potential to strengthen critical thinking. However, empirical evidence assessing its effectiveness particularly at the elementary school level remains scarce. Most existing cooperative learning studies do not specifically measure critical thinking indicators, nor do they evaluate hybrid cooperative models that combine collaborative investigation with individual analytical responsibility (Ridwanulloh et al, 2022; Bumi et al, 2025: Usman et al, 2025). Recent findings on digital-assisted cooperative learning also suggest that structured collaborative tasks can significantly enhance elementary students' reasoning abilities (JEMS, 2023), further indicating a need to examine hybrid models like Find Match in Group more rigorously.

Therefore, this study fills a significant research gap by investigating the effectiveness of the Find Match in Group model in improving the mathematical critical thinking skills of fifth-grade students. This research provides new empirical evidence on cooperative learning approaches specifically designed to develop early-stage critical thinking in mathematics.

METHOD

This study employed a quasi-experimental method using a pretest–posttest control group design. This design was selected because it allows a direct comparison between the experimental group—taught using the Find Match in Group model—and the control group, which received conventional instruction. The design is appropriate for measuring changes in students' mathematical critical-thinking skills before and after the intervention.

The study was conducted at SDN Leuwinutug 04 with Grade V students as participants. A purposive sampling technique was used to select two classes with relatively similar characteristics. Class 5A, consisting of 30 students, served as the experimental group, while Class 5B, with 31 students, served as the control group. Both classes shared comparable academic backgrounds and learning environments, making them suitable for comparison.

The research instrument consisted of a mathematical critical-thinking test in the form of open-ended items based on indicators adapted from Ennis. The test materials focused on the topic of volume of three-dimensional shapes (cubes and rectangular prisms). The assessed indicators included:

1. identifying and focusing on the problem;
2. defining terms and concepts;
3. selecting appropriate strategies or procedures for solving problems.

Two versions of the instrument were administered: a *pretest* to measure students' initial critical-thinking abilities, and a *posttest* to measure their performance after the intervention. In addition, Student Worksheets (LKPD) were used in the experimental class to guide activities involving collaborative reasoning and problem solving.

The study was carried out over five instructional sessions. The procedures consisted of the following stages:

1. **Pretest**
   Both groups were administered a pretest to assess their initial mathematical critical-thinking skills. The results showed that the two groups had comparable baseline abilities.
2. **Treatment**
   The experimental class received instruction using the *Find Match in Group* learning model following its structured sequence:
   a. forming student groups,
   b. presenting objectives and problems,
   c. guiding group discussion,
   d. distributing question and answer cards,
   e. having students collaboratively match cards,
   f. facilitating presentations and justification of solutions.
   Throughout the activities, students were encouraged to identify given information, define mathematical concepts, choose appropriate strategies, justify their reasoning, and communicate solutions. Meanwhile, the control class received conventional instruction as typically implemented by the teacher.
3. **Posttest**
   After the treatment phase, both groups completed a posttest to measure improvement in their mathematical critical-thinking skills.

Data were analyzed using both descriptive and inferential statistical techniques.

1. **Descriptive Statistics**
   Descriptive analyses included the calculation of mean, median, mode, maximum and minimum scores, range, variance, and standard deviation for pretest and posttest results.
2. **Normality Test**
   The Kolmogorov–Smirnov test was used to determine whether the data were normally distributed.
3. **Difference Test**
   a. If data were normally distributed → parametric *t-test* was applied.
   b. If data were not normally distributed → nonparametric *Mann–Whitney U test* was used.

4. **N-Gain Score**
   The *normalized gain* (n-gain) was calculated to measure the level of improvement in each group. The n-gain results were further analyzed using the same inferential procedures applied to the pretest and posttest scores.

These analytical procedures were used to determine whether the *Find Match in Group* learning model produced a significantly greater improvement in mathematical critical-thinking skills compared to conventional instruction. Procedures research can see in Figure 1.

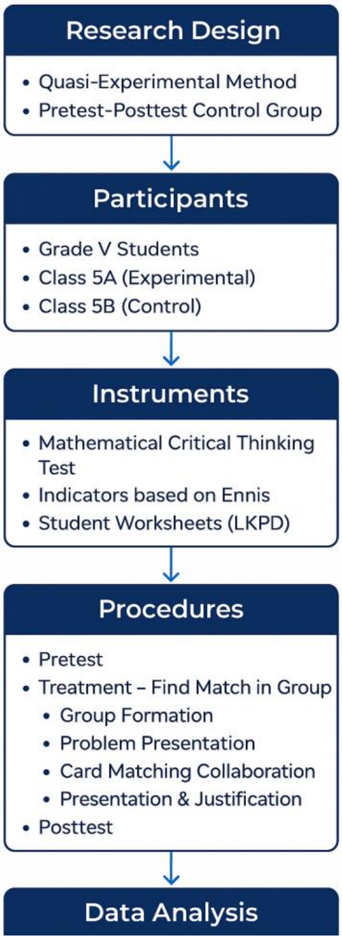

Figure 1. Research Procedure

RESULTS AND DISCUSSION

Based on the research that has been conducted, research data in the form of pre-test and post-test scores were obtained, which were then processed and analyzed to determine the improvement in mathematical critical thinking skills. The results are presented in Table 1.

Table 1. Descriptive Statistics

Value	Experiment		Control		N-Gain	
	Pre Test	Post Test	Pre Test	Post Test	Experiment	Control
Mean	0.767	43.233	1.419	54	54	42
Median	0	42	0	53	53	40
Modus	0	35	0	44	44	38
Maximum	7	58	12	73	73	76
Minimum	0	35	0	43	43	17
Range	7	23	12	30	30	60
Variance	3.220	48.323	101.978	79.787	79.787	179.365
Standard deviation	1.794	6.951	10.098	8.932	8.932	13.393

Based on Table 1, it can be seen that the pre-test scores in the experimental class and the control class were different. The average pre-test score of the control class was almost double that of the experimental class. The lowest score in both classes was 0, while the highest score was different, with the control class scoring higher. However, many students in both the experimental and control classes scored 0.

The post-test results for the experimental and control classes showed an improvement. The average post-test score for the experimental class was 43.233, while the average post-test score for the control class was 35.387. This shows that the average scores for the two classes were different. The lowest scores obtained by both classes also increased. The lowest score in the experimental class was 35, while the lowest score in the control class was 15. However, the highest score in the control class was higher than that in the experimental class, which was 61, while the highest score in the experimental class was 58.

Furthermore, the data were analyzed for hypothesis testing using inferential statistics, and the results are shown in Table 2.

Table 2. Inferential Statistics Results

	Kolmogorov-Smirnov test					
	Pre Test		Post Test		N-Gain	
	Experiment	Control	Experiment	Control	Experiment	Control
P value	0.00001	0.00004	0.49076	0.21081	0.36001	0.20988
α	0.05	0.05	0.05	0.05	0.05	0.05
	Mann Whitney Test		T-Test		T-Test	
P value	0.50926		0.00083		0.000607	
α	0.05		0.05		0.05	
Results	Not Any Different		Any Different		Any Different	

Based on Table 1, the pre-test, post-test, and n gain results were first tested for normality using the Kolmogorov-Smirnov test. For the pre-test results of the experimental class, a p-value of 0.00001 was obtained, which is smaller than $\alpha = 0.05$, indicating that the data is not normally distributed. The control class pre-test results obtained a p-value of 0.00004, which is smaller than $\alpha = 0.05$, meaning that the data is not normally distributed. Because both data sets are not normally distributed, we continued with the Mann Whitney non-parametric test. From the Mann Whitney test analysis, a p-value of 0.50926 was obtained, which is greater than $\alpha = 0.05$, meaning that there was no difference in the average results of the pre-test for the experimental class and the control class.

For the post-test results of the experimental class, a p-value of 0.49076 was obtained, which is greater than $\alpha = 0.05$, indicating that the data is normally distributed. The pre-test results of the control class obtained a p-value of 0.21081, which is greater than $\alpha = 0.05$, indicating that the data is normally distributed. Since both data sets are normally distributed, the parametric t-test was used. From the t-test analysis, a p-value of 0.00083 was obtained, which is less than $\alpha = 0.05$, meaning that there is a difference in the mean of the post-test results between the experimental class and the control class.

To see the increase in both classes, we continued with the calculation of n gain, which will also be analyzed using Kolmogorov Smirnov. For the experimental class, the p-value obtained was 0.36001, which is greater than $\alpha = 0.05$, indicating that the data is normally distributed. For the control class n gain, the p-value obtained was 0.20988, which is greater than $\alpha = 0.05$, indicating that the data is normally distributed. Since both data sets are normally distributed, we proceeded to use the parametric t-test statistic. From the t-test analysis, a p-value of 0.000607 was obtained, which is smaller than $\alpha = 0.05$, meaning that there is a difference in the increase in mathematical critical thinking skills between the experimental class and the control class.

This study focused on the mathematical critical thinking skills of elementary school students. This study was conducted in 5th grade over four meetings. In the first meeting, the researcher first observed the class to determine the students' initial conditions in learning, their learning styles, and their prior knowledge. The researcher also used this opportunity to approach the students so that they would not be surprised when learning with the researcher.

The second meeting began with a pre-test in the experimental and control classes, followed by treatment in the experimental class, which consisted of mathematics learning using the Find Match in Group learning model. Learning in the experimental class was carried out based on the Find Match in Group learning syntax, in which students discussed in groups to solve problems. They were given question cards and answer cards, and then they had to find pairs within their groups and explain the solutions and answers to their friends in the group.

At first, the students were confused because they were not used to group learning in mathematics lessons. They also could not understand HOTS questions, whether it was identifying known elements, defining terms, or determining solution strategies. At the elementary school level, teachers need to put in extra effort to facilitate student discussions because elementary school students cannot be left entirely to their own devices to discuss. There must be guidance, stimulation, and motivation from the teacher so that students dare to try to develop strategies to solve a problem.

In the first step of the Find Match in Group learning process, students were divided into four groups, each of which was given the freedom to choose a learning topic. However, to limit the scope and ensure focus on the material being taught, the researcher provided several different problems that were still within the same context. During the group discussion stage, there were obstacles in solving the problems, as students did not fully understand the meaning of the problems because they were not familiar with HOTS questions. The teacher's role here was to visit each group to facilitate and motivate students to be brave in expressing their opinions and to be critical in solving problems. In the third meeting, students became accustomed to identifying and understanding problems, with the teacher's continued assistance. Students were also not shy about asking questions. In the last meeting, students were able to identify known and unknown elements just by listening to the teacher read a problem. There were also some students who could answer orally but when asked to solve the problem according to the method or strategy they mentioned in the Student Worksheet, they had difficulty because they did not know what formula to use. At this stage, students began to actively ask each other questions and express their opinions. This can be seen in Figure 2.

Figure 2. Find Match in Group Learning Model Activity

When this learning model was first implemented, it took a long time for students to complete their group assignments, which meant that the practice process using question cards and answer cards could only be done once. Each group that had completed the assigned problems was given several question and answer cards. Each student in the group had to find a partner who matched the cards they had received. After finding a partner, the pair had to understand and explain the solution to the problem. Pairs that were correct had to present their solution to their groupmates. For the first meeting, the researcher wrote the answers in detail on the answer cards, starting from the known elements and questions to the final solution. This was done deliberately by the researcher to attract the students' attention first. After the students find a partner, they discuss whether their card pairs are correct or not. At this stage, all students are required to think actively, because this is a collaboration between two people, but each person must be able to analyze the cards they have obtained so that their card pairs are correct and they are able to explain them to their friends in the group.

Students who have found a partner present their answers to their friends in their group. This is to minimize students' lack of understanding of the question, because presenting in front of a large group is considered less effective. In a large classroom, children's voices may not be heard clearly, which will affect their presentation. In small groups, students are more likely to ask questions if there is something they do not understand, and students who already understand can become peer tutors for students who do not understand.

The results indicate that the *Find Match in Group* model had a significant positive effect on students' mathematical critical thinking abilities. This improvement aligns with prior findings showing that cooperative, inquiry-based, and problem-centered learning approaches effectively promote higher-order thinking (Setyaningsih & Abadi, 2024; Yuliyanti & Rahayu, 2021; Hidayat & Sariningsih, 2018). However, unlike conventional cooperative learning structures, which often emphasize participation without requiring explicit justification (Slavin, 2015; Johnson & Johnson, 2018), the *Find Match in Group* model integrates card-matching activities that obligate students to articulate and defend their reasoning. This structural emphasis on *justified matching* provides a cognitive novelty that has been scarcely examined in previous research on cooperative learning (Rosidah et al., 2022; Sejati & Widjajanti, 2024).

Moreover, early classroom observations revealed that students were initially unfamiliar with analyzing HOTS-type mathematical tasks a finding consistent with national research showing persistent weaknesses in Indonesian students' reasoning, conceptual analysis, and representational fluency (Irawan & Kencanawaty, 2017; Kartimi et al., 2012; Nugraha et al., 2020). As the intervention progressed, students increasingly demonstrated core indicators of critical thinking focusing on problems, defining terms, and selecting appropriate strategies as described by Ennis (2011). This suggests that the repeated structure of identifying, matching, and explaining concept relationships functioned as a *reasoning scaffold* (Sweller, 2011; Kirschner et al., 2006), enabling more systematic cognitive growth compared to conventional instruction.

The verbal justification phase in small groups also contributed substantially to improved articulation and reasoning. This finding is in line with studies asserting that opportunities for dialogic reasoning enhance mathematical argumentation (Yani et al., 2023; Mercer & Littleton, 2007) and that structured peer explanation strengthens conceptual understanding (Chi et al., 2018). The model's emphasis on collaborative justification addresses a frequently cited weakness in commonly used cooperative learning models such as Group Investigation and Make a Match, where individual accountability often remains low (Ariana, 2016; Gillies, 2016). The *Find Match in Group* model therefore introduces a novel design element: blending individual responsibility (through card-matching justification) with collaborative cognitive engagement.

The consistent pattern of improvement across pre-test, post-test, and N-gain results also aligns with research demonstrating that cooperative learning models incorporating structured reasoning tasks yield higher cognitive gains than unstructured group work (Gillies, 2016; Webb et al., 2014). Recent digital-assisted cooperative learning studies similarly emphasize that structured interaction improves reasoning quality (JEMS, 2023; Sari & Lestari, 2022). Yet, prior work has rarely examined hybrid cooperative models that combine matching tasks with conceptual justification—a gap that the present study directly addresses.

Overall, the findings provide empirical evidence that the *Find Match in Group* model offers an innovative and impactful learning alternative by integrating structured reasoning, peer explanation, and accountability mechanisms. This research contributes novelty by (1) evaluating a hybrid cooperative reasoning model not previously examined at the elementary level, (2) highlighting justification-based card matching as a cognitive scaffold, and (3) presenting empirical proof that such structured hybrid models significantly enhance critical thinking in mathematics. These contributions extend the existing literature on cooperative learning and provide a foundation for further development of reasoning-oriented instructional models

CONCLUSIONS AND SUGGESTIONS

The findings of this study show that the *Find Match in Group* learning model is effective in enhancing elementary students' mathematical critical thinking skills. Students in the experimental class demonstrated higher post-test and N-Gain scores than those in the control class, indicating that structured collaboration, card-matching reasoning activities, and opportunities to articulate solutions significantly contributed to their cognitive development. The model also helped reduce students' initial difficulties with HOTS-type tasks through scaffolding and group discussion, demonstrating that this approach can serve as a meaningful alternative to conventional instruction for fostering analytical and reflective thinking in mathematics.

Future research may expand the implementation of the *Find Match in Group* model to different grade levels, mathematical topics, or broader cognitive domains such as creative thinking or problem-solving. Researchers may also explore integrating this model with digital tools or technology-assisted learning environments to determine whether such combinations further enhance students' engagement and reasoning. Additionally, more rigorous designs such as randomized controlled trials or mixed-method approaches may be employed to examine deeper aspects of student interaction, reasoning processes, and long-term retention.

ACKNOWLEDGEMENTS

We would like to thank the Indonesian Defense University for providing a full month of training to elementary school teachers, enabling them to conduct research in their respective schools and write up their findings in scientific articles.

CONFLICT OF INTEREST

The authors declare that there are no potential conflicts of interest related to the research, writing, or publication of this article.

AUTHOR CONTRIBUTIONS

The authors contributed equally to the formulation of the research concept, data collection, data analysis, manuscript writing, and approval of the final manuscript for publication.

REFERENCES

Ariana, R. (2016). *Perbandingan model Group Investigation dan Make a Match ditinjau dari perhatian orang tua terhadap prestasi belajar siswa* (Skripsi). Universitas Muhammadiyah Magelang.

Belland, B. R. (2017). *Instructional scaffolding in STEM education: Strategies and efficacy evidence*. Springer.

Bumi, P. S., Umam, R., & Saregar, A. (2025). Optimization of Physics Learning on Uniform Linear Motion (GLB) and Uniformly Accelerated Linear Motion (GLBB) Through Interactive Virtual Practicum Simulation Based on Phet. *Islamic Journal of Integrated Science Education (IJISE),* 4(2), 107–117. https://doi.org/10.30762/ijise.v4i2.5850

Chi, M., Roy, M., & Hausmann, R. (2018). Observing tutorial dialogues: Learning mechanisms and impact on conceptual change. *Cognition and Instruction, 36*(1), 1–23.

Diani, R., Herliantari, H., Irwandani, I., Saregar, A., & Umam, R. (2019). Search, Solve, Create, and Share (SSCS) Learning Model: The Impact on the Students' Creative Problem-Solving Ability on the Concept of Substance Pressure. *Jurnal Penelitian Fisika Dan Aplikasinya (JPFA),* 9(1), 65. https://doi.org/10.26740/jpfa.v9n1.p65-77

Ennis, R. H. (2011). *The nature of critical thinking: An outline of critical thinking dispositions and abilities*. University of Illinois.

Fisher, R. (2005). *Teaching children to think*. Nelson Thornes.

Gillies, R. M. (2016). Cooperative learning: Review of research and practice. *Educational Psychology Review, 28*(3), 353–374.

Hidayat, W., & Sariningsih, R. (2018). The influence of problem-based learning on critical thinking in mathematics. *Jurnal Pendidikan Matematika, 12*(1), 12–25.

Huda, S., Anggraini, L., Saputri, R., Syazali, M., & Umam, R. (2019). Learning model to improve the ability to understand mathematical concepts. *Prisma,* 173(2), 173–181.

Huda, S., Suherman., Komarudin., Syazali, M., & Umam, R. (2020). The Effectiveness of Al-Qurun Teaching Model (ATM) Viewed from Gender Differences: The Impact on Mathematical Problem-Solving Ability. *IOP Conf. Series: Journal of Physics: Conference Series,* 1467 (2020) 012001. https://doi.org/10.1088/1742-6596/1467/1/012001

Huda, S., Muawanah, Munifah, Syazali, M., Palupi, E. K., Umam, R., & Tortop, H. S. (2020). Islamic education in supply chain system by prioritizing manners as a success factor of millennial generation on socializing. *International Journal of Supply Chain Management,* 9(2), 853–863.

Irawan, A., & Kencanawaty, G. (2017). Peranan kemampuan verbal dan kemampuan numerik terhadap kemampuan berpikir kritis matematika. *AKSIOMA: Journal of Mathematics Education, 5*(2), 110–118. https://doi.org/10.24127/ajpm.v5i2.669

JEMS. (2023). Live worksheet-assisted cooperative learning dan kemampuan berpikir kritis matematis. *Journal of Mathematics and Science Education, 11*(2), 580–588.

Johnson, D. W., & Johnson, R. T. (2018). *Cooperation in the classroom*. Interaction Book Company.

Kartimi, K., Liliasari, L., & Permanasari, A. (2012). Pengembangan alat ukur berpikir kritis pada konsep senyawa hidrokarbon untuk siswa SMA. *Jurnal Pendidikan MIPA, 13*(1), 18–25.

Kemendikbud. (2016). *Kurikulum 2013: Kompetensi Dasar Sekolah Dasar*. Kementerian Pendidikan dan Kebudayaan Republik Indonesia.

King, A. (2002). Structuring peer interaction to promote high-level cognitive processing. *Learning and Instruction, 12*(4), 423–455.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work. *Educational Psychologist, 41*(2), 75–86.

Mercer, N., & Littleton, K. (2007). *Dialogue and the development of children's thinking*. Routledge.

Munifah, M., Romadhona, A, N., Ridhona, I., Ramadhani, R., Umam, R., & Tortop, H, S. (2019). How to Manage Numerical Abilities in Algebra Material?. *Al-Jabar : Jurnal Pendidikan Matematika,* 10(2), 223-232. https://doi.org/10.24042/ajpm.v10i2.5325

Munifah, M., Huda, S., Ulfi, D, H., Subandi, S., Syazali, M., Umam, R. (2019). The Use of Management Strategies to Attract the Public's Interest in Pesantren: A New Model for Pesantren Dynamics Study. *International Journal of Innovation, Creativity and Change.* 8(8). 363-383.

Nugraha, F., Maulani, S., & Wulan, R. (2020). Analysis of students' difficulties in solving HOTS questions. *Jurnal Pendidikan Indonesia, 9*(2), 250–260.

OECD. (2019). *PISA 2018 Results (Volume I): What Students Know and Can Do.* OECD Publishing. https://doi.org/10.1787/5f07c754-en

Polya, G. (1957). *How to solve it*. Princeton University Press.

Ridwanulloh, M. U., Huda, S., & Umam, R. (2022). Innovative Leadership Management: The Pattern of School Quality Development at SMP Muhammadiyah 2 Inovasi Malang. *Progresiva : Jurnal Pemikiran Dan Pendidikan Islam,* 11(01), 25–42. https://doi.org/10.22219/progresiva.v11i01.20742

Rosidah, M., Putra, D. A., & Faradita, M. N. (2022). Penerapan collaborative learning untuk meningkatkan kemampuan berpikir kritis siswa dalam matematika kelas 6 SD. *Jurnal Pendidikan Tambusai, 5*(3), 10888–10897.

Saregar, A., Sunyono, Haenilah, E. Y., Hariri, H., Putra, F. G., Diani, R., Misbah, & Umam, R. (2022). Natural disaster education in school: A bibliometric analysis with a detailed future insight overview. *International Journal of Educational Methodology,* 8(4), 743-757. https://doi.org/10.12973/ijem.8.4.743

Sari, R., & Lestari, I. (2022). Digital-assisted cooperative learning to improve reasoning. *Jurnal Teknologi Pendidikan, 24*(3), 221–233.

Schoenfeld, A. H. (2013). *Mathematical thinking and problem solving*. Routledge.

Sejati, E. O. W., & Widjajanti, D. B. (2024). Menumbuhkan critical thinking pada anak usia SD melalui cooperative learning. *Jurnal Guru Sekolah Dasar, 1*(1), 51–59.

Setyaningsih, T. D., & Abadi, A. M. (2024). Keefektifan PBL setting kolaboratif ditinjau dari prestasi belajar aljabar, kemampuan berpikir kritis, dan kecemasan siswa. *Jurnal Riset Pendidikan Matematika, 5*(2).

Sleman, D. I. K. (2022). Peningkatan pemahaman konsep matematika dan kemampuan berpikir kritis siswa melalui pembelajaran eksploratif. *Jurnal Pendidikan, 4*(1), 1–11.

Slavin, R. E. (2015). *Cooperative learning: Theory, research, and practice* (2nd ed.). Allyn & Bacon.

Sumarni, S., Ramadhani, R., Sazaki, Y., Astika, R. T., Andika, W, D., & Prasetiyo, A, E. (2019). Development of "Child Friendly ICT" Textbooks to Improve Professional Competence of Teacher Candidates : A Case Study of Early Childhood Education Program Students. *Journal for the Education of Gifted Young Scientists,* 7(3), 643-658. https://doi.org/10.17478/jegys.596095

Sumarni, S., Pertiwi, S, T, Y., Rukiyah., Andika, W, D., Astika, R, T., Abdurrahman., & Umam, R. (2019). Behavior in Early Childhood (2-3) Years: A Case Study on the Use of Gadgets in Social Environments. *International Journal of Innovation, Creativity and Change.* 8(8), 834-404.

Sweller, J. (2011). Cognitive load theory. *Psychological Review, 118*(2), 193–232.

Usman, M., Pramudawardani, H., Umam, R., & Takahashi, H. (2025). Synthesizing A Framework and Establishing Content Validity of An Energy Literacy Instrument for Indonesian Students. *Islamic Journal of Integrated Science Education (IJISE),* 4(3), 175–185. https://doi.org/10.30762/ijise.v4i3.6993

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Webb, N. M., Franke, M. L., Ing, M., Wong, J., Fernandez, C., Shin, N., & Turrou, A. C. (2014). Engaging with others' mathematical ideas. *Journal of Educational Psychology, 106*(4), 1127–1135.

Widayanti, A. (2019). Penggunaan metode pembelajaran Group Investigation untuk pengajaran matematika. *Bangun Rekaprima, 5*(1), 73–82.

Yani, J., Maharani, I., Dalimunthe, N. F., Pulungan, F. K., & Fakhri, N. (2023). Peningkatan kemampuan berpikir kritis dan pemecahan masalah matematis melalui cooperative learning tipe TPS Square vs TPS Share. *FARABI: Jurnal Matematika dan Pendidikan Matematika, 7*(2).

Yasin, M., Huda, S., Putra, F. G., Syazali, M., Umam, R., & Widyawati, S. (2020). IMPROVE Learning Model and Learning Independence: Influence and Interaction on Mathematics Problem-Solving Abilities in Islamic Boarding School. *Journal of Physics: Conference Series,* 1467(1). https://doi.org/10.1088/1742-6596/1467/1/012003

Yuliyanti, A., & Rahayu, T. S. (2021). Efektivitas model pembelajaran Problem Solving dan Group Investigation terhadap kemampuan berpikir kritis siswa SD: Meta-Analisis. *Thinking Skills and Creativity Journal, 4*(1), 40–47.