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META ANALYSIS: A METACOGNITION APPROACH TO STUDENTS' MATHEMATICAL PROBLEM SOLVING ABILITIES

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Abstract

Solving challenges in real life requires the ability to solve problems. Students have a variety of difficulties when solving mathematical issues, such as trouble comprehending the problem due to prior problems they have encountered. It is clear from the outcomes of the teaching and learning activities that the students' problem solving skills are still lacking from the questions that were presented to the 36 students. The obtained average was 63.75, with 67% of the data being classically complete. According to the 2018 PISA survey results, Indonesia was placed 64th out of 65 participating countries. Finding the increase in problem-solving skills through a metacognitive method is the goal of this study. Utilising a meta-analysis methodology, this study examines many publications published in both domestic and foreign journals. Because it makes use of statistics and numerical computations, this meta-analysis is quantitative. Twelve representative samples of pertinent national periodicals are used in this meta-analysis study. The study of the meta-analysis's data leads to the conclusion that the examined publications had effect sizes that fall into three categories: extremely high (17% of all studies), negligible (17% of all articles), and high (17% of all papers). In the medium category, the effect size makes up 17% of the whole piece. In the low category, the effect size makes up 25% of the full article. Based on the calculation results, the t_count value was 9.63 and the t_table value was 1.96; Thus the conclusion is obtained t_count=9.63>t_tabel=1.96. So H_0 is rejected. So, the average problem solving ability of experimental group students is more than the average of control group students.

Keywords: **:** Learning, Mathematics, Metacognitive, Problem, Solving

Abstrak

Salah satu cara untuk menangani masalah dalam kehidupan nyata adalah dengan memecahkan masalah. Saat siswa memecahkan masalah matematika, mereka menghadapi sejumlah masalah. Beberapa di antaranya berasal dari masalah yang pernah dihadapi oleh siswa sebelumnya. Hasil kegiatan belajar mengajar sebelumnya menunjukkan bahwa kemampuan pemecahan masalah 36 siswa masih rendah. Indonesia menduduki peringkat ke-64 dari 65 negara yang mengikuti survei PISA pada tahun 2018, dengan rata rata 63,75 dan kentutasan klasik 67%. Penelitian ini bertujuan untuk menemukan apakah pendekatan metakognitif dapat meningkatkan kemampuan pemecahan masalah. Untuk penelitian ini, sejumlah artikel di jurnal nasional dan internasional direview menggunakan metode meta-analisis. Meta-analisis ini bersifat kuantitatif karena menggunakan perhitungan angka dan statistik penelitian meta analisis ini menggunakan 12 sampel jurnal yang relevan pada jurnal nasional. Berdasarkan hasil meta-analisis dapat disimpulkan bahwa artikel yang telah dianalisis memiliki nilai effect size dengan kategori pengaruh yang sangat tinggi sebesar 17% dari keseluruhan artikel, effect size denngan kategori diabaikan sebesar 17%,effect size dengan kategori tinggi sebesar 17% dari keseluruhan artikel,. effect size dengan kategori sedang sebesar 17% dari keseluruhan artikel. effect size dengan kategori rendah sebesar 25% dari keseluruhan artikel. Berdasarkan hasil perhitunan diperoleh nilai sebesar 9,63 dan nilai sebesar 1,96; dengan demikian diperoleh kesimpulan . Sehingga ditolak. Jadi, rata rata kemampuan pemecahan masalah siswa kelompok eksperimen lebih dari rata rata siswa kelompok control.

Kata kunci: *Masalalah*, *Matematika*, *Metakognitif*, *Pembelajaran*, *Pemecahan*

INTRODUCTION

The five competences in mathematics education are mathematical problem solving, mathematical communication, mathematical reasoning, mathematical connections, and

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mathematical representation, according to the National Council of Teachers of Mathematics, or NCTM. The endeavour to identify a solution to a problem is known as problem solving (Polya, 1973). In the meantime, problem solving is a crucial component in resolving issues in real life, claims Maryam (2013). Students have a variety of difficulties when solving mathematical issues, such as trouble comprehending the problem due to prior problems they have encountered. Investigating one's capacity for problem solving is one of the challenges of studying mathematics. Through problem solving, students can learn to deepen their understanding of mathematical concepts by applying mathematics to real problems that are worked on carefully (Edy *et al* , 2017). The Minister of Education and Culture's Regulation Number 22 of 2016, which includes problem solving as one of the knowledge and skill competencies in the basic and secondary education process standards, demonstrates the significance of problem solving in Indonesia.

The importance of students' ability to solve problems was emphasized by Sumarmo that the aim of teaching mathematics and the heart of mathematics is problem solving (Soekisno, 2002; Lestari & Rosdiana, 2018; Hanifah & Nuraeni, 2020). However, in reality, students' mathematical problem solving abilities are still far from expectations (Ulandari, Amry, & Saragih, 2019; Simamora & Saragih, 2019; Xu, et al., 2022). According to several studies (Albab, Saputro, & Nursyahidah, 2017; Indriana & Maryati, 2021; Lusiana, Armiat, & Yerizon, 2022). students' proficiency in solving mathematical problems is really low. Numerous national and international polls have been conducted, which attest to this. According to the 2018 PISA survey findings, Indonesia was placed 64th out of 65 participating nations (Rumapea, 2019; Masfufah & Afriansyah, 2021).

Researchers conducted a Preliminary Study which was carried out from 13 October 2023 to 30 October 2023 at SMA Negeri 1 Tegal City. Researchers observed teaching and learning activities at the school. Learning is still less active, this can be seen when the teacher delivers the material, students' responses to the teacher's questions when giving the material are still lacking. Students are also still reluctant to do assignments. Meanwhile, it is clear from the outcomes of the teaching and learning activities that students' problem solving skills are still lacking from the questions that were presented to the 36 students. The obtained average was 63.75, with 67% of the data being classically complete.The completion criteria indicate the percentage of competency achievement level so that it is expressed

with a maximum score of 100 (one hundred). A maximum score of 100 is the ideal completion criterion.

From this description, there has been a lot of previous research regarding metacognitive approaches to improve problem-solving abilities. So researchers are interested in collecting previous research for further analysis. Based on this, research will be carried out to examine in more depth the ability to solve problems using a metacognitive approach. The aim is to determine the increase in problem solving abilities using a metacognitive approach.

To solve a difficulty in life, one needs problem-solving abilities. Likewise, in the mathematics learning process, problem solving ability is important because it is needed to solve mathematical problems. To gain the ability to solve problems, a person must have a lot of experience in solving various problems. Various research results show that children who are given a lot of problem-solving practice have higher grades than children who receive less practice. (NCTM, 2000) states that problem solving plays a dual role in the school curriculum. On the one hand, it is a basic means or tool for studying mathematics, on the other hand, it is the main goal in learning mathematics.

According to (Widiasih et al, 2018), problem solving is a thinking process to find the right way to get a solution. Olkin and Schoenfeld (Sumarno, 2013) suggest that a good problem solving question should have the following characteristics: (1) can be accessed without using a lot of machines, meaning that the problem involved is not due to difficult calculations, (2) can be solved in several ways or open ended problem form, (3) illustrates important mathematical ideas, (4) does not contain solutions with tricks, (5) can be expanded and generalized. Based on this description, it can be concluded that problem solving ability is a skill that students must have to solve a mathematical problem. In this research, problem solving ability is a skill in applying the knowledge you have to solve problems by using systematic solving steps to get a solution to the problem.

According to Sumarmo, as quoted by Rosita & Yuliawati (2017) the indicators for solving mathematical problems are:

1. Identify data adequacy for problem solving;
2. Construct a mathematical model and solve it for a real world issue or scenario;
3. Choose and use techniques to address problems in mathematics and non-mathematics;

4. Examine the accuracy of the answer or results and explain or interpret the findings in light of the original;
5. Use maths in a meaningful way.

In solving problems, it is very essential to have addressing issues steps so that the problem being solved can be resolved in a structured and easy to understand manner. In his research, Irfan (2017) stated that there were several figures who put forward problem solving steps, namely Polya, Krulick, Rudnick. According to Polya (1978) describes the steps for addressing issues, namely: (1) understanding the issues; (2) create a resolution plan; (3) excute the strategy; and (4) rechecking answers. According to Krulick & Rudnick (1996), there are five steps to problem solving, namely: (1) reading while reflecting, (2) analyzing and planning, (3) organizing strategies, (4) getting answers, and (5) checking answers again.

According to Costa (2001), metacognition is the capacity to reflect on and assess the effectiveness of one's cognitive skills, create a strategy to generate the knowledge required to discover a solution to a problem, and decide which strategic steps to take. Stated differently, metacognition is the capacity to recognise our own knowledge as well as our ignorance. In line with that, Flavell in Multadah (Masni, 2015) also stated that metacognition is a person's awareness of how he learns, how he assesses the difficulty of a problem, how he observes his level of understanding, how he uses the various information he has to achieve his goals and how he assesses his learning progress.Students frequently follow directions to complete tasks without understanding what they are doing, why they are doing it, or even what to do with the task itself (Costa, 2001). Good metacognition is a necessary skill for problem solvers. Students that possess metacognitive awareness are taught to consistently devise the most effective plan for sorting, retaining, identifying again, arranging, and resolving the information they encounter. Pupils will become accustomed to constantly observing, managing, and assessing their own work (Masni, 2015). According to Costa (2001), problem solving uses metacognition with the following actions:

1. plan a series of actions before starting a task.
2. monitor yourself during the implementation of the plan.
3. support or adjust plans consciously.
4. evaluate the action after completion.

Accordingly, yoong (Murni, 2013) defined metacognition as the capacity to manage one's own mental processes, which consists of:

1. monitoring the strategies and thought processes used in carry out a task
2. search for alternative task completion
3. checking the accuracy and rationality of the answers.

Someone who has metacognitive skills is someone who has ability to develop effective strategies, control cognitive strategies, motivate self, have good self-confidence and independent learning (Nindiasari, 2013). Heller, et al. (Nindiasari, 2013) believes that metacognitive activities can implied through:

1. Awareness is a person's ability to recognize explicit and implicit information.
2. Observation, namely asking yourself and explaining in your own words to stimulate understanding.
3. Arrangement, namely comparing or contrasting answers that are more appropriate in solving problems.

METHODS

Utilising a meta-analysis methodology, this study examines many publications published in both domestic and foreign journals. The main study under analysis is the impact of metacognitive skills on students' capacity for problem-solving. This research is quantitative because it uses numerical calculations and statistics where meta-analysis is a study of a number of research results on the same problem. Data was gathered via looking at multiple papers in national journals on Google Scholar or by conducting a Google Scholar search. The keywords used in this digestion are The Effectiveness of the Metacognitive Approach to Problem Solving Ability . This meta-analysis is quantitative because it uses numerical calculations and statistics. This meta-analysis research uses 12 samples of relevant journals in national journals.

This article uses coding to make data collection easier. The coding carried out is by replacing the names of the articles to be analyzed with codes A1 to A12. The steps for meta-analysis research according to Davud B. Wilson and George A. Kelley in (Anggreni et al, 2019), namely:

a. Choose the issue or subject under investigation. The effectiveness of the metacognitive approach to problem solving ability is the issue and subject of this study
b. Determine the research period - previous research used as a data source.
c. Look for research reports from various sources that are relevant to the topic you want to research.
d. Read the titles and abstracts of educational journals and see how the contents match the topic you want to research.
e. Concentrating on study on issues research methodology, including forms of research, research locations and times, methodologies, population, samples, sampling strategies, data anlysis strategies, and findings
f. Categorize each research. g. Analyze the conclusions found.

Because the articles used use different data analysis, the following effect size derivative formula is needed.

Table 1. Effect size criteria

Criteria	Information
	Ignored
	Small
	Medum
	High
	Very high
	Very high influence

After measuring the effect size, then calculate the similarity of the two averages with the following hypothesis:

pupils in the experimental group have a lower average problem solving skill than pupils in the control group

students in the experimental group had an average problem solving skill that is higher than that of the control group

(Sudjana, 2005).

Information:

: experimental class average

: control class average

: number of experimental class students

: number of control class students

: combined standard deviation

: variance of experimental class test scores

: variance of control class test scores

Accept if where is obtained from the distribution list t with and probability . Refuse to .

RESULTS AND DISCUSSION

In light of the studies that have been carried out, using the Meta Analysis research method has a research procedure to describe and combine the findings from several similar studies. The research procedure in Meta Analysis research consists of defining the problem, collecting literature, converting and correcting information, describing any data obtained, considering the effectiveness of the studies observed. From the description of data obtained from several similar studies using Meta Analysis, the final result is a research conclusion. The aim of this research is to examine several previous research results regarding metacognitive approaches to problem solving abilities. Codes A1 through A12 stand for the first and twelfth articles, respectively, and are classified as national and international articles Can be seen in table 2.

Table 2 Distribution of article distribution

No	Article Code	Writer	Year	Article title	Journal
1	A1	Solikhah, N; Winarti, ER; and Kurniasih, AW	2014	The Effectiveness of the Guided Inquiry Model with a Metacognitive Skills	KREANO JOURNAL Volume 5

				Approach to Problem Solving Ability	Number 1 June 2014
2	A2	Geni Sri Elita1, Mhmd Habibi, Aan Putra, and Nelpita Ulandari	2019	The Effect of Problem Based Learning with a Metacognition Approach on Mathematical Problem Solving Ability	Mosharafa: Journal of Mathematics Education 447 Volume 8, Number 3, September 2019
3	A3	Nita Hidayati	2018	Effectiveness of the Metacognitive Learning Model in Improving Students' Mathematical Problem Solving Abilities in Linear Program Courses	Proceedings of the 2018 National Seminar on Mathematics and Mathematics Education (Sesiomadika).
4	A4	Yudi Darma, Imam Sujadi	2011	The Effectiveness of Heuristic Strategies with a Metacognitive Approach and an Investigative Approach on Mathematical Problem Solving Abilities on the Main Material of Sequences and Series in View from the Creativity of Class XII Madrasah Aliyah Students in Pontianak	JMEE Volume I Number 2, December 2011
5	A5	Nur Rizka	2018	Application of the PBL Model	Equatorial

				with a Metacognitive Approach to Improve Middle School Students' Mathematical Problem Solving Abilities	Journal of Education and Learning
6	A6	Hanifah Nur Lestari, Ondi Suganda, Rahma Widiantie	2017	The Relationship Between Metacognitive Knowledge and Problem Solving Ability Through the Problem Based Learning Model (on the Concept of Environmental Pollution in Class X	Quagga: Journal of Education and Biology Volume 9, Number 2, July 2017
7	A7	Syahrina Syam, Ulfiani Rahma, Nursalam	2016	The influence of metacognitive knowledge and visual learning styles on the mathematical problem solving abilities of class IX students at SMP Negeri 2 Barombong, Gowa Regency	MaPan: Journal of Mathematics and Learning Volume 4, Number 2, December 2016
8	A8	Suratmi Agustina Sri Purnami	2017	The Influence of Metacognitive Strategies on Mathematical Problem Solving Ability in terms of Students' Perceptions of Mathematics Subjects	UNION: Journal of Mathematics Education Vol 5 No 2, July 2017
9	A9	Sutarto , Intan Bi Hastut , Doris Fuster-Guille´n , Jessica Paola Palacios Garay ,	2022	The Effect of Problem-Based Learning on Metacognitive Ability in the Conjecturing Process of Junior High School Students	Hindawi Education Research International

		Ronald M. Herna ´ndez , and Ehsan Namaziandost			
10	A10	Akhsanul In'am , Zulkifley Mohammad , Zeti Yusmira Jaludin	2021	Effectiveness of the Metacognitive – Based Algebra Learning Model	Vytauto Didziojo Universiteto Svietmo Akademija International Electronic Journal of Elementary Education Vol.1, Issue 2, March, 2009.
11	A11	Gökhan ÖZSOY , Ayşegül ATAMAN	2009	The effect of metacognitive strategy training on mathematical problem solving achievement	
12	A12	Mulyono and R Hadiyanti	2018	Analysis of mathematical problem-solving ability based on metacognition on problem-based learning	International Conference on Mathematics, Science and Education 2017 (ICMSE2017)

Next, calculate the Effect Size to determine the impact that the metacognitive approach has on mathematical problem solving abilities. The results of calculating the effect size for articles A1 to A12 are presented in the following table.

Table 3 Effect size value for each article

Article Code	Experiment			Control			Effect Size	Criteria
	Mean	elementary school	N	Mean	elementary school	N		
A1	81.42	187,377	33	75.22	107,725	32	0.05755	ignored

A2	72.58	8.74	17	65	8.4	17	0.90238	tall
A3	27.65	19.5	25	24.28	17.06	26	0.19754	small
A4	67.72	12.8	88	67.01	10.8	98	0.06574	ignored
A5	25.58	7.15	33	24.76	4.05	31	0.20247	small
A6	72.17	8.62	34	66.55	8.28	34	0.67874	currently
A7	82.52	12.8	93	71.18	8.96	93	1.26563	very high
A8	43.77	0.081	31	37	7.18	32	0.94290	tall
A9	4.36	1.09	30	2.63	1.12	30	1.54464	very high influence
A10	51.71	8.52	38	48.58	8.34	38	0.37530	small
A11	46.46	9.03	24	27.83	9.63	23	1.93458	very high influence
A12	71.47	9.95	36	66.11	10.25	35	0.52293	currently

Next, calculate the equality test of the two averages to find out whether there is an increase in problem-solving abilities using a metacognitive approach. The following is a table of data analysis results to calculate the similarity of two averages,

Table 4 is the combined standard deviation table

Article Code	Experiment			Control			Gab Elementary School
	Mean	elementary school	N	Mean	elementary school	N	
A1	81.42	187,377	33	75.22	107,725	32	44977.56
A2	72.58	8.74	17	65	8.4	17	153.30
A3	24.28	19.5	25	27.65	17.06	26	680.08
A4	67.01	12.8	88	67.72	10.8	98	386.55
A5	25.58	7.15	33	24.76	4.05	31	93.48
A6	72.17	8.62	34	66.55	8.28	34	170.66
A7	71.18	12.8	93	82.52	8.96	93	332.50
A8	43.77	0.081	31	37	7.18	32	81.56
A9	4.36	1.09	30	2.63	1.12	30	30.36
A10	48.55	8.52	38	51.71	8.34	38	174.41

A11	46.46	9.03	24	27.83	9.63	23	184.15
A12	71.47	9.95	36	66.11	10.25	35	228.48

pupils in the experimental group have a lower average problem sloving skill than pupils in the control group.

students in the experimental group had a average problem solving skill that is higher than that of the control group.

It is accepted if at a significance level of or 5%. is taken from the distribution list with probabilities . Refuse to . Based on the calculation results, a value of 9.63 and a value of 1.96 were obtained; Thus a conclusion is obtained . So it was rejected. Therefore, students in the experimental group have a higher average problem solving skill than students in the control group

The articles that have been analysed have an effect size value with a very high influence category of 17% of the total articles, an effect size with a negligible category of 17%, and an effect size size with the high category of 17% of the total article. These findings are based on the research conducted, which examined the effectiveness of the metacognitive approach on students' problem solving abilities generally. In the medium category, the effect size makes up 17% of the whole piece. In the low category, the effect size makes up 25% of the total article.

Table 2 shows that students' abilities to solve mathematical problems are not positively impacted by the metacognitive method. The table displays that the effect size value determined in the article titled " Effectiveness of the Guided Inquiry Model with a Metacognitive Skills Approach to Problem Solving Ability ". This is because some group members are unable to work together, thus hampering teamwork. Groups that have already worked on tend to disturb those that have not yet been completed. Even though their teamwork is quite good, the sense of competition to be the best group makes them act this way. This is demonstrated by the results of the group development scores which show that group awards are only dominated by certain groups. This is what makes the learning process less than ideal, which in turn makes the outcomes less than ideal.

Table 2 demonstrates how much of an impact the metacognitive technique has on students' capacity to solve mathematical problems. The impact size found in the paper titled

"The Effect of Problem Based Learning with a Metacognition Approach on Mathematical Problem Solving Ability ". is 0.90238, as the table illustrates. The average difference test results also demonstrate that students in the experimental group had a greater average level of problem solving ability than students in the control group. The results of this research are in line with Krisna's research (Lestari, Suganda & Widiantie, 2017) revealed that student learning achievement using the problem based learning model assisted by metacognitive questions was much better than without the assistance of metacognitive questions. This is because there are more opportunities for students to engage in learning activities when using a problem-based learning model with a metacognitive approach. Students will be able to think freely by solving issues by using a problem-based learning model with a metacognition approach that makes them aware of their own cognitive activity or anything associated with them.

In Table 2 it can be seen that the metacognitive approach has a small influence on students' mathematical problem solving abilities. It can be seen in the table that the effect size obtained was 0.19753 in the article entitled " Effectiveness of the Metacognitive Learning Model in Improving Students' Mathematical Problem Solving Ability in Linear Program Courses ". After attempting to comprehend a problem for long time, understanding occurs when someone suddenly gains clarity, recognises that there is a relationship between one aspect and another, and then comprehends both the relationship and its meaning.

In Table 2 it can be seen that the metacognitive approach does not have a positive influence on students' mathematical problem solving abilities. It can be seen in the table that the effect size obtained was 0.06574 in the article entitled " Effectiveness of Heuristic Strategies with a Metacognitive Approach and Investigative Approach on Mathematical Problem Solving Ability on the Main Topic of Sequences and Series in View from the Creativity of Class XII Students of Madrasah Aliyah in Pontianak ". A factor that is often ignored in various mathematics education research is student learning creativity, including creativity in achieving mathematics . When faced with this phenomena, some students are unable to react intelligently; instead of becoming more excited about studying, they become more excited about watching television.

Table 2 demonstrates how little of an impact the metacognitive technique has on students' capacity to solve mathematical problems. The table in the article labelled "The

effect size obtained was 0.20246" shows this. "Application of the PBL Model with a Metacognitive Approach to Improve Middle School Students' Mathematical Problem Solving Ability ". The results of the average difference test also show that there is an average difference mathematical problem solving abilities between the experimental class and the control class. It can be concluded that students' final mathematical problem solving abilities between the experimental class and the control class are significantly different .

Table 2 indicates that students' abilities to solve mathematical problems are moderately impacted by the metacognitive method. It can be seen in the table that the effect size obtained was 0.67874 in the article entitled "The Relationship Between Metacognitive Knowledge and Problem Solving Ability through the Problem Based Learning Model (on the Concept of Environmental Pollution in Class" Students in the experimental group solve problems at a higher rate than those in the control group on average. Nonetheless, this study concludes that PBL has a great deal of promise for enhancing and developing students' metacognitive understanding. Despite the fact that the percentage results do not clearly demonstrate the positive requirements in each metacognitive indicator, there is little Students' metacognitive understanding will gradually advance.

Table 2 shows that students' abilities to solve mathematical problems are not positively impacted by the metacognitive method. It can be seen in the table that the effect size obtained was 1.26562 in the article entitled "The influence of metacognitive knowledge and visual learning styles on the mathematical problem solving abilities of class IX students at SMP Negeri 2 Barombong, Gowa Regency". research result This shows that class IX SMP students Negeri 2 Barombong still has moderate metacognitive knowledge. This is brought about by both extrinsic (such as the students' surroundings and the teachers' efforts to instruct them) and intrinsic (such as the participants' objectives and aspirations, students' talents, and students' situations) aspects. Students' metacognitive knowledge and visual learning styles have a significant influence on students' mathematical problem solving abilities. If students' metacognitive knowledge and visual learning styles increase, students' mathematical problem solving abilities will also increase. Thus, there is a relationship between metacognitive knowledge and visual learning styles of students at school and mathematical problem solving abilities that should not be ignored.

Based on Table 2, it can be seen that the metacognitive approach has a high influence on students' mathematical problem solving abilities. It can be seen in the table that the effect size obtained was 0.94290 in the article entitled " The Influence of Metacognitive Strategies on Mathematical Problem Solving Ability in terms of Students' Perceptions of Mathematics Subjects ". The results of the average difference test also show that the group of students who apply metacognitive strategies has better mathematical problem solving abilities of this group of students implement conventional strategies. In other words, metacognitive strategies provide mathematical problem solving abilities that are better than conventional strategies. Metacognitive strategies are better because metacognitive strategies are basic in solving problems, namely consciously connecting new information in problems with old information, choose the appropriate thinking strategy freely self-ability, planning, monitoring and evaluating.

Table 2 shows that students' skills to solve mathematical problems are significantly impacted by the metacognitive method. The impact size found in the article titled "The Effect of Problem-Based Learning on Metacognitive Ability in the Conjecturing Process of Junior High School Students" is 1.54464, as the table illustrates. According to Temur et al. (2019), educators need to be capable of teaching mathematics going forward. Boost the calibre of mathematical education. Furthermore, Alzahrani (2017) discovered that the implementation of cognitively based mathematics instruction requires careful planning, with a specific focus on enhancing the monitoring and organisation of students' thought processes when addressing mathematical issues.

Table 2 demonstrates how little of an impact the metacognitive technique has on students' capacity to solve mathematical problems. The effect size found in the article titled "Effectiveness of the Metacognitive – Based Algebra Learning Model" is 0.37530, as the table illustrates. As a result of this study, there were notable variations in the metacognitive knowledge and skills of the groups who had received instruction in metacognitive strategies and those that had not at the conclusion of the experiment.

Table 2 indicates that students' abilities to solve mathematical problems are moderately impacted by the metacognitive method. The table displays the effect size of 1.93458 in the article "The effect of metacognitive strategy training on mathematical problem solving achievement." The study's findings support the following conclusions: (1)

Problem-based learning improves students' problem-solving skills; and (2) A student's aptitude for solving mathematical puzzles is strongly correlated with their level of metacognition. The ability of a pupil to solve problems will increase with their level of metacognition. The findings indicate that although students can answer all of the questions and are at the level of tacit use, they do not comprehend the purpose of the methods or what they entail. Pupils who apply their cognitive abilities to a sufficient degree are able to solve difficulties, gain new knowledge through problem solving, and identify the best course of action even when it is not a good one. In order to solve issues and provide process indicators and results, students at the strategic use level are able to broadly employ and embrace a variety of suitable techniques.

Table 2 indicates that students' abilities to solve mathematical problems are moderately impacted by the metacognitive method. The effect size found in the article "Analysis of mathematical problem-solving ability based on metacognition on problem-based learning" is 0.52293, as the table illustrates. The findings demonstrate that while students with a degree of quiet use are able to answer every question, they are unable to comprehend the purpose of the approach or its application. With a certain amount of conscious use, students can solve difficulties and develop new information through problem solving, showing signs of comprehension and identifying the approach taken—even if it wasn't the best. Pupils who reach the strategic usage level are capable of applying and embracing a wide range of suitable techniques to resolve issues, meet process benchmarks, and produce outcomes. There were no reflective users among the students in this study.

CONCLUSION

The study of the meta-analysis's data leads to the conclusion that the examined publications had effect sizes that fall into three categories: extremely high (17% of all studies), negligible (17% of all articles), and high (17% of all papers). The effect size in the medium category is 17% of the entire article. The effect size in the low category is 25% of the entire article. Based on the calculation results, a value of 9.63 and a value of 1.96 were obtained; Thus a conclusion is obtained . So it was rejected. So, the average problem solving ability of experimental group students is more than the average of control group students.

For further meta-analysis studies, it is recommended to synthesize research on how learning models or learning approaches can facilitate students in increasing their interest in

learning so that it will have an impact on trained reasoning abilities. In addition, further research should explore whether problem-based learning media can explain this relationship. between PBL and students' mathematical problem solving abilities. Therefore, future research must involve more primary research so that the findings obtained are more comprehensive

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REFERENCES

Darma, Y. (2012). *Efektivitas Strategi Heuristik dengan Pendekatan Metakognitif dan Pendekatan Investigasi Terhadap Kemampuan Pemecahan Masalah Matematika Pada Materi Pokok Barisan dan Deret Ditinjau dari Kreativitas Siswa Kelas XII Madrasah Aliyah di Pontianak* (Doctoral dissertation, UNS (Sebelas Maret University)).

Desmita. (2014). Psikologi Perkembangan Peserta Didik. Bandung: Remaja Rosdakarya.

Elita G. N, Habibi M, Putra A, & Ulandari N (2019). Pengaruh Pembelajaran Problem Based Learning dengan Pendekatan Metakognisi terhadap Kemampuan Pemecahan Masalah Matematis. Mosharafa Jurnal Pendidikan Matematika

Hadiyanti, R. (2018, March). Analysis of mathematical problem-solving ability based on metacognition on problem-based learning. In *Journal of Physics: Conference Series* (Vol. 983, No. 1, p. 012157). IOP Publishing.

Hidayati, N. (2019). EFEKTIFITAS MODEL PEMBELAJARAN METAKOGNITIF DALAM PENINGKATAN KEMAMPUAN PEMECAHAN MASALAH MATEMATIK MAHASISWA DALAM MATA KULIAH PROGRAM LINIER. *Prosiding Sesiomadika*, *1*(1b).

In'am, A., Mohammad, Z., & Jaludin, Z. Y. (2021). Effectiveness of the Metacognitive-Based Algebra Learning Model. *Pedagogy Studies/Pedagogika*, *141*(1).

Lestari, H. N., Suganda, O., & Widiantie, R. (2017). Hubungan Antara Pengetahuan Metakognitif dengan Kemampuan Pemecahan Masalah melalui Model Problem

Based Learning (PBL) pada Konsep Pencemaran Lingkungan di Kelas X. *Quagga: Jurnal Pendidikan dan Biologi*, *9*(02), 23-31.

Nurmalasari, L. R., Winarso, W., & Nurhayati, E. (2015). Pengaruh kemampuan metakognisi terhadap hasil belajar matematika di SMP Negeri 2 Leuwimunding Kabupaten Majalengka. *Nusantara of Research*, *2*(2), 133–147.

OECD. (2019, 05 15). *PISA Result*. Retrieved from Result-in-Focus: https://www.oecd.org/pisa

Özsoy, G., & Ataman, A. (2009). The effect of metacognitive strategy training on mathematical problem solving achievement. *International Electronic Journal of Elementary Education*, *1*(2), 67-82.

Rizka, N., Hartoyo, A., & Suratman, D. (2018). Penerapan model PBL dengan pendekatan metakognitif untuk meningkatkan kemampuan pemecahan masalah matematis siswa SMP. *Jurnal Pendidikan dan Pembelajaran Khatulistiwa (JPPK)*, *7*(9).

Sholikhah, N., Winarti, E. R., & Kurniasih, A. W. (2014). Keefektifan model guided inquiry dengan pendekatan keterampilan metakognitif terhadap kemampuan pemecahan masalah. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *5*(1), 18-25.

Suratmi dan Agustina Sri Purnami. (2017). Pengaruh Strategi Metakognitif terhadap Kemampuan Pemecahan Masalah Matematis ditinjau dari Presepsi Siswa terhadap Mata Pelajaran Matematika. UNION: Jurnal Pendidikan Matematika Vol 5 No 2, Juli 2017

Sutarto, Dwi Hastuti, I., Fuster-Guillén, D., Palacios Garay, J. P., Hernández, R. M., & Namaziandost, E. (2022). The effect of problem-based learning on metacognitive ability in the conjecturing process of junior high school students. *Education Research International*, *2022*, 1-10.

Syam, S., Rahman, U., & Nursalam, N. (2016). Pengaruh Pengetahuan Metakognisi Dan Gaya Belajar Visual Terhadap Kemampuan Pemecahan Masalah Matematika Siswa Kelas Ix Smp Negeri 2 Barombong Kabupaten Gowa. *MaPan: Jurnal matematika dan Pembelajaran*, *4*(2), 231-244.

TIMSS. 2004. *Highlights From the Trends in International Mathematics and Science Study (TIMSS) 2003*. [Online]. Tersedia: http://www.warwick.ac.uk/ETS/Publications/Guides/cal.htm. [13 Nopember 2010]