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Meta Analysis: The Effect of *Treffinger* Learning Model on Students' Mathematical Creative Thinking Ability

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ABSTRACT

This study aims to determine the effect of Treffinger learning model on students' mathematical creative thinking ability, based on previous research articles. The method used in this research is meta-analysis. The results of the analysis through the calculation of the t-test and effect size show that $t_{value} = 110.4 > 1.96 = t_{table}$, indicating that the average mathematical creative thinking ability of students who use the Treffinger model is higher than the average students who follow conventional learning. Thus, there is a significant influence between the mathematical creative thinking ability of students using the Treffinger model, with an effect size of 1.02, which is classified in the large category. In addition, previous research shows that the Treffinger learning model is more effective than the discovery model in enhancing mathematical creativity. With the help of the Treffinger model, which encourages creativity and inquiry, students can actively participate in their education and maximize their capacity for creative thinking. It is recommended that the Treffinger model be combined with STEM, science, or problem-solving-based approaches and include scaffolding to get better results.

ABSTRAK

Penelitian ini bertujuan untuk mengetahui pengaruh model pembelajaran *Treffinger* terhadap kemampuan berpikir kreatif matematis siswa, berdasarkan artikel-artikel penelitian sebelumnya. Metode yang digunakan dalam penelitian ini adalah meta analisis. Hasil analisis melalui perhitungan uji-t dan *effect size* menunjukkan bahwa $t_{hitung} = 110{,}4 > 1{,}96 = t_{tabel}$, mengindikasikan bahwa rata-rata kemampuan berpikir kreatif matematis siswa yang menggunakan model *Treffinger* lebih tinggi dibandingkan dengan rata-rata siswa yang mengikuti pembelajaran konvensional. Dengan demikian, terdapat pengaruh signifikan antara kemampuan berpikir kreatif matematis siswa yang menggunakan model *Treffinger*, dengan *effect size* sebesar 1,02, yang tergolong dalam kategori besar. Selain itu, penelitian sebelumnya menunjukkan bahwa model pembelajaran *Treffinger* lebih efektif daripada model *discovery* dalam meningkatkan kreativitas matematika. Dengan bantuan model *Treffinger*, yang mendorong kreativitas dan inkuiri, siswa dapat secara aktif berpartisipasi dalam pendidikan mereka dan memaksimalkan kapasitas mereka untuk berpikir kreatif. Disarankan agar model *Treffinger* dikombinasikan dengan pendekatan berbasis

STEM, sains, atau pemecahan masalah dan menyertakan *scaffolding* untuk mendapatkan hasil yang lebih baik.

INTRODUCTION

Mathematics is a discipline that has a central role in various aspects of life, underlies the development of science, and advances human thinking (Muslich, 2007; Rifa et al., 2020; Sunita, 2020). Mathematics is always present in everyday human life, from small things to complex technological advances (Damanik et al., 2021; Shadiq, 2014). Mathematics not only offers educational values that educate the nation, but also helps shape student character, such as the ability to think creatively. Based on this, to achieve the goals of learning, one of the aspects that students must master is having the ability to think creatively mathematically.

Creativity is reflected in the ability to produce and convey new ideas to solve problems. These ideas can arise from completely new ideas or through combining existing ideas, both based on experience and previously known information, so as to produce something meaningful (Maharani & Indrawati, 2018; Munandar, 2012). According to Mahmudi in (Rochaya et al., 2019), mathematical creative thinking ability is more focused on ways that produce a variety of new and diverse solutions to solve mathematical problems that have an open nature. Creative thinking ability has four indicators, namely fluency, flexibility, originality, and elaboration(Dewi & Juandi, 2023; Nursamira et al., 2023; Nursilawati et al., 2019; Panjaitan, 2020; Rifa et al., 2020; Torrance, 1974; Treffinger et al., 2002). Students' mathematical creative thinking skills in their application in real life still need improvement. In (Munandar, 2012) revealed that creativity receives less attention in formal education, even though it is very important for the development of children's potential, and contributes significantly to the progress of science and cultural arts.

Various learning models have been attempted to improve students' creative thinking skills, one of which is the Treffinger learning model. In (Munandar, 2012) stated that the Treffinger model is an approach that encourages creative learning and directly focuses on developing creativity problems. The Treffinger model consists of three stages, namely basic tools, practice with process, and working with real problems (Wardani et al., 2017). The basic tools stage focuses on developing divergent thinking skills. At the practice with process stage, students are trained to combine the thinking process with complex feelings. While at the working with real problems stage, students are directly involved in creative problem solving. These three stages aim to understand and describe how to improve students' creative thinking skills in solving math problems.

The effectiveness of the Treffinger learning model on students' mathematical creative thinking skills still requires a more in-depth study. Various studies that have been conducted show mixed results regarding the impact of this model in enhancing mathematical creativity. To determine how much the features of earlier research affect the connection between the Treffinger model and mathematical creative thinking skills, a meta-analysis of the literature was done. A meta-analysis examines multiple primary studies on a given subject, accounting for differences in effect magnitude (Anzani & Juandi, 2022; Ndiung et al., 2021). This justification highlights the significance of carrying out an extensive meta-analysis on the impact of the Treffinger model on Indonesian students' mathematics creative thinking abilities throughout the previous 10 years. To evaluate its utilization and better notice general trends, this is required.

METHOD

This research applies meta-analysis, which is a method that brings together the results of two or more previously published studies, with the aim of integrating findings and collecting more data from similar topics, so as to understand the impact of these topics (Glass, 2015; Grant & Hunter, 2006; Hernandez et al., 2020; Tania et al., 2024). The data collected is quantitative data. This research analyzes previous studies that examine the effect of Treffinger learning model on students' mathematical creative thinking ability. This research follows the stages previously applied by (Borenstein et al., 2009) and (Pigott, 2012), namely determining inclusion criteria, data collection and variable coding, and statistical analysis. Then identify the influence of variables caused by the subject and make conclusions.

The population used in this study were accredited journals that have been published at the national level. The research instrument used was a variable coding sheet. The use of this coding process not only helps researchers in analyzing data, but also prevents data omission. The inclusion criteria used were articles that met the criteria of (a) articles/journals included in the span of the last 10 years, (b) articles published in SINTA indexed journals and Proceedings, and (c) articles/journals containing statistical data on the number of samples (), average (*mean*), and standard deviation.

Studies involving meta-analyses are distinguished by an extensive search of the literature. A precise description of the hypothesis acts as a road map for the investigation. Collecting all relevant studies is essential, as a lack of data from a particular study may lead to bias. Empirical data were collected from published articles found through searches in electronic databases, such as Researchgate and Google Scholar. Seven primary studies met the inclusion criteria and could be analyzed. Several comparison groups were compared in certain research. The articles obtained were categorized as follows.

Table 1. Grouping of article sources used

Code	Research Title	Researcher Name	Year	Journal/Proceedings Source
J1	Implementation of The Treffinger Model Based STEM Approach to Students' Creative Thinking Skill	Lestari, E., & Hadi, S.	2022	INSECTA: Integrative Science Education and Teaching Activity Journal
J2	Penerapan Model Pembelajaran *Treffinger* untuk Meningkatkan Kemampuan Berpikir Kreatif Matematis Siswa	Rifa, R., Sujana, A., & Romdonah, I.	2020	Jurnal Analisa
J3	Pengaruh Model Pembelajaran *Treffinger* Terhadap Kemampuan Berpikir	Sunita, N. W.	2020	Widyadari: Jurnal Pendidikan

Code	Research Title	Researcher Name	Year	Journal/Proceedings Source
	Kreatif dengan Mengontrol *Adversity Quotient*			
J4	Developing Mathematical Creative Thinking (CT) Ability Students Through The Treffinger Learning Model (LM)	Lambertus, L., Salam, M., Rezkiati, R., Suhar, S., & Hasnawati, H.	2023	AKSIOMA: Jurnal Program Studi Pendidikan Matematika
J5	Pengaruh Model Pembelajaran *Treffinger* Berpendekatan Saintifik Terhadap Kemampuan Berpikir Kreatif Ditinjau dari Gaya Kognitif Siswa	Wardani, N. P. C., Sariyasa, & Marhaeni, A. A. I. N.	2017	PENDASI: Jurnal Pendidikan Dasar Indonesia
J6	Pendekatan Pemecahan Masalah dalam *Setting* Model *Treffinger* Terhadap Kemampuan Berpikir Kreatif dan Kejujuran	Rochaya, M., Fatah, A., & Rafianti, I.	2019	Seminar Nasional Penelitian Pendidikan Matematika (SNP2M) 2019 UMT
J7	Pengaruh Model Pembelajaran *Treffinger* Terhadap Kemampuan Berpikir Kreatif Pelajaran Matematika Materi Bangun Ruang	Maharani, R. K., & Indrawati, D.	2018	Jurnal Penelitian Pendidikan Guru Sekolah Dasar

After categorizing the sources of the articles used, the articles were analyzed as follows.

Table 2. Article analysis

Category	Group	Many Articles
Year of Publication	2017-2020	3
	2021-2024	4
Sample Size	Less than or equal to 30	4
	31 or more	3
Publication Source	Journal	6
	Proceedings	1

Furthermore, statistical analysis was carried out. To determine how much influence the variables have, calculations were made using the effect size value with Cohen's formula as follows.

$$d = \frac{\underline{x}_1 - \underline{x}_2}{s_{comb}}$$

with

$$s_{comb} = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$$

Explanation.
d : effect size
$\underline{x}_1$: experimental group average
$\underline{x}_2$: control group average
s_{comb} : combined standard deviation
s_1 : standard deviation of the experimental group
s_2 : control group standard deviation
n_1 : sample size of the experimental group
n_2 : control group sample size

The effect size results obtained are interpreted based on the following classification.

Table 3. Effect Size Criteria from Cohen's

Interpretation	Effect Size
Weak	$0.2 \leq ES < 0.5$
Medium	$0.5 \leq ES < 0.8$
Large	$0.8 \leq ES < 1.3$
Very Large	$ES \geq 1.3$

In addition, this study aims to identify the effect of Treffinger learning model on students' mathematical creative thinking ability, so hypothesis testing using t-test is needed. The hypothesis used in this study is as follows.

$H_0 : \mu_1 \leq \mu_2$ (The average mathematical creative thinking ability of students who use treffinger learning is less than equal to the average mathematical creative thinking ability of students who do not use treffinger learning).

$H_1 : \mu_1 > \mu_2$ (The average mathematical creative thinking ability of students who use treffinger learning is more than the average mathematical creative thinking ability of students who do not use treffinger learning).

The formula applied to test the t-test hypothesis according to (K. E. Lestari & Yudhanegara, 2017) is as follows.

$$t = \frac{\underline{x}_1 comb - \underline{x}_2 comb}{s_{comb}\sqrt{\frac{1}{n_1 comb} - \frac{1}{n_2 comb}}}$$

Explanation.
t : t_{value}
$\underline{x}_1 comb$: combined experimental group average
$\underline{x}_2 comb$: combined control group average
s_{comb} : combined standard deviation
$n_1 comb$: sample size of the combined experimental group
$n_2 comb$: sample size of the combined control group

with the test criteria being reject H_0 if $t_{value} > t_{table}$, where $t_{table} = t_{1-\frac{1}{2}(0.05)}$ with $dk = n_1 comb + n_2 comb - 2$ and $\alpha = 0.05$.

RESULT AND DISCUSSION

The research results from the various articles were classified, explained, and analyzed to understand the impact of the Treffinger learning model on students' mathematical creative thinking skills. The following is the level of influence produced by the application of Treffinger learning on students' mathematical creative thinking skills.

Table 4. Statistical analysis of the article

Code	n		$\underline{x}$		Standard Deviation		$Standard\ Deviation^2$		Effect Size	Inter
	E	K	E	K	E	K	E	K		
J1	29	28	88.90	80.69	6.61	6.31	43.69	39.82	0.76	M
J2	26	26	28.35	23.35	8.16	8.98	66.72	80.70	0.46	M
J3	10	16	86.9	74.38	5.36	6.4	28.77	41.05	1.16	L
J4	26	25	68.61	56.97	19.62	16.53	384.94	273.24	1.07	L
J5	34	34	136.1	127.2	6.93	10.05	47.99	100.98	0.82	L
J6	36	35	64.86	54.10	12.61	12.01	159.09	144.42	0.99	L
J7	33	33	83.71	63.44	9.62	9.39	92.54	88.17	1.87	VL
Comb	194	197	79.63	68.59	11.06	10.6	122.39	112.26	1.02	L
							$s_{comb} = 10.83$			

$$S_{combcontrol} = \sqrt{\frac{(n_1-1)s_1^2 + \cdots + (n_p-1)s_p^2}{n_1+n_2+\cdots+n_p-p}}$$

$$= \sqrt{\frac{(28-1)39.82 + \cdots + (33-1)88.17}{28+26+\cdots+33-7}} = 10.6$$

$$S_{combexperimental} = \sqrt{\frac{(n_1-1)s_1^2 + \cdots + (n_p-1)s_p^2}{n_1+n_2+\cdots+n_p-p}}$$

$$= \sqrt{\frac{(29-1)43.69 + \cdots + (33-1)92.54}{29+26+\cdots+33-7}} = 11.06$$

and then

$$S_{comb} = \sqrt{\frac{(194-1)122.39 + (197-1)112.26}{194+197-2}} = 10.83$$

so that

$$d = \frac{\underline{x}_1 - \underline{x}_2}{s_{comb}} = \frac{79.63 - 68.59}{10.83} = 1.02$$

Based on Table 4, the statistical analysis shows the comparison between the experimental class (E) and the control class (K) of the seven articles reviewed. The results indicate that the mean score ($\underline{x}$) of students' mathematical creative thinking ability in the experimental class is higher than the control class for all articles. In addition, the effect size value of each article varied, with categories ranging from medium (M), large (L), to very large (VL). Overall, the combined effect size value (1.02) is in the large category, indicating that the Treffinger model has a significant effect on improving students' mathematical creative thinking skills compared to conventional learning. This is reinforced by the following t-test statistical analysis as follows.

1) Determine the hypothesis.
   $H_0 : \mu_1 \leq \mu_2$ (The average mathematical creative thinking ability of students who use treffinger learning is less than equal to the average mathematical creative thinking ability of students who do not use treffinger learning).
   $H_1 : \mu_1 > \mu_2$ (The average mathematical creative thinking ability of students who use treffinger learning is more than the average mathematical creative thinking ability of students who do not use treffinger learning).
2) Determining the significance level.
   The significance level used is $\alpha = 0.05$
3) Testing criteria.
   Reject H_0 if $t_{value} > t_{table}$
4) Determine t_{table} and t_{value}.
   $t_{table} = t_{1-\frac{1}{2}(0.05)} = t_{0.975}$ and
   $dk = n_1comb + n_2comb - 2 = 194 + 197 - 2 = 389$ obtained $t_{table} = 1.96$

   Then calculate t_{value} as follows.

$$t_{value} = \frac{\underline{x}_1comb - \underline{x}_2comb}{s_{comb}\sqrt{\frac{1}{n_1comb} - \frac{1}{n_2comb}}} = \frac{79.63 - 68.59}{11.39\sqrt{\frac{1}{194} - \frac{1}{197}}} = \frac{11.04}{0.1} = 110.4$$

5) Conclusion.
   Obtained $t_{value} = 110.4 > 1.96 = t_{table}$ so that H_0 is rejected. This means that the average mathematical creative thinking ability of students who use treffinger learning is more than the average mathematical creative thinking ability of students who do not use treffinger learning. This implies that the treffinger learning model has a significant effect on students' mathematical creative thinking skills.

Based on Table 4, it can be seen that the effect size results of the 7 articles are in the weak, medium, large, and very large categories. The average effect size of the seven articles is 1.02, which indicates that the Treffinger learning model has a large influence on students' mathematical creative thinking skills.

1. Effect Size weak category.

Statistical analysis revealed that no publications fell into the weak effect size group. This demonstrates that the Treffinger learning model significantly impacted students' mathematics creative thinking abilities in every study that was examined. With no findings indicating negligible or unimportant impacts, every study examined demonstrated that the use of the Treffinger model had a genuine and pertinent influence on enhancing students' capacity for mathematical creativity.

Additionally, every effect magnitude that was noted fell into one of the medium to extremely big groups. This indicates that the Treffinger learning model continuously has a significant positive influence on students' learning of mathematics, encouraging deeper comprehension and creativity in the solution of mathematical problems in addition to helping them think more imaginatively. The consistency of these findings suggests that, in the context of teaching mathematics, the Treffinger model is a worthwhile learning technique to enhance students' capacity for creative thought.

2. Effect Size medium category.

With values of 0.76 and 0.46, respectively, the medium effect size category was derived from two articles: (E. Lestari & Hadi, 2022), and (Rifa'i et al., 2020). These findings suggest that, albeit at a moderate level, the Treffinger learning model significantly influences students' capacity for mathematical creativity. Though not to a very great degree, the application of this methodology has been shown to enhance students' capacity for creative thought. These effect size figures show that the Treffinger model outperforms the traditional approach in addition to having a beneficial effect.

According to research by E. Lestari & Hadi (2022), students who take classes that employ the STEM-based Treffinger model are more capable of creative thought than those that do not. Through a more practical and contextual approach, the STEM (Science, Technology, Engineering, and Mathematics) method in conjunction with the Treffinger model was able to encourage students to think creatively in this study. Because students are encouraged to think critically and come up with innovative solutions to pertinent problems, this demonstrates how integrating the Treffinger learning model with STEM-based approaches can enhance students' mathematical creativity.

In the meantime, a study conducted by Rifa et al. (2020) verified that students who were taught using the Treffinger model possessed superior mathematics creative thinking abilities in contrast to those who were taught using the traditional method. According to this study, the Treffinger model encourages students to take an active role in their education by giving them the chance to experiment with different approaches to problem-solving and come up with original, imaginative ideas. As a result, even though the impact size attained falls into the medium range, the Treffinger model continues to produce encouraging outcomes and can serve as a useful substitute for enhancing students' mathematical creativity in the classroom.

3. Effect Size large category.

With respective scores of 1.16, 1.07, 0.82, and 0.99, four articles—(Sunita, 2020); (Lambertus et al., 2023); (Wardani et al., 2017); (Rochaya et al., 2019)—obtained a large effect size category. These findings suggest that students' capacity for mathematical creativity is significantly impacted by the Treffinger learning paradigm. In addition to having a powerful effect, this model regularly demonstrates that students who are taught using the Treffinger technique are more likely to be able to think creatively than those who are taught using the traditional learning paradigm. This suggests that the Treffinger model has the potential to be a useful strategy for fostering students' growth in mathematical creativity.

According to research by Sunita (2020), students who used the Treffinger model shown a notable improvement in their capacity for creative thought when compared to those who used the traditional model. Students who used the Treffinger model were better equipped to generate original ideas and approach mathematical problems creatively, which was evident not only in the end results but also in the learning process. This demonstrates that the Treffinger approach can foster deeper creative thinking abilities and raise student involvement in the learning process.

According to Lambertus et al. (2023), students who utilized the Treffinger model outperformed those who learnt using the discovery model in terms of their mathematics creative thinking abilities. In contrast to the discovery model, which focuses more on examining preexisting notions, the Treffinger model offers a more adaptable framework for encouraging creation. In the study, students taught with the Treffinger model were not only more active in developing problem-solving strategies, but also more able to present creative and innovative solutions compared to students using the discovery approach.

Research by Wardani et al. (2017) and Rochaya et al. (2019) further supports the aforementioned findings by demonstrating that students who employed the Treffinger model outperformed those who learnt traditionally in terms of their mathematical creative thinking abilities. This holds true for both the scientific method and problem-solving techniques. According to Wardani et al. (2017), the scientifically grounded Treffinger model fosters students' capacity for creative thought while assisting them in gaining a deeper understanding of mathematical ideas. Students can participate more actively in the learning process with this method, which facilitates their ability to combine theoretical knowledge with original, creative thoughts.

However, Rochaya et al. (2019) pointed out that the Treffinger model's problem-solving approach gives students the chance to practice creative thinking by posing problems derived from actual circumstances. In addition to making it easier for students to comprehend mathematical ideas, this paradigm fosters critical and creative thinking in them when they encounter challenging issues. The Treffinger model's ability to foster students' mathematical creativity is strengthened by this blend of in-depth theoretical knowledge and innovative problem-solving techniques. Overall, the four research' results lend credence to the idea that the Treffinger model works well for fostering students' capacity for mathematical creativity in a variety of learning environments by utilizing both scientific and problem-solving methodologies.

4. Effect *Size* very large category.

With an impact size value of 1.87, the article (Maharani & Indrawati, 2018) falls into the very large effect size category, demonstrating that the Treffinger learning model significantly and significantly influences students' capacity for mathematical creativity. This effect size value suggests that the Treffinger model is not only successful but also significantly enhances students' capacity for original thought when studying mathematics. According to the study's findings, applying the Treffinger model regularly yields far superior outcomes to alternative teaching strategies, particularly when it comes to enhancing students' creativity when tackling mathematical difficulties.

Maharani & Indrawati's (2018) study demonstrated how the Treffinger model can help students better comprehend the material of building space. According to this study, students who used the Treffinger model shown a notable increase in their capacity for creative thought, particularly when it came to coming up with solutions to problems involving geometric principles. Students were able to solve complex problems in novel ways by using this model, which helped them develop deeper and more creative thinking skills. The claim that the Treffinger model can be a better choice for teaching mathematical ideas that call on higher-order creative thinking abilities is supported by these findings.

In addition to analyzing how much influence the Treffinger model has on students' mathematical creative thinking skills, the significance of this influence was also analyzed. Through the t test, it was obtained $t_{value} = 110.4 > 1.96 = t_{table}$, which shows that the average mathematical creative thinking ability of students using Treffinger model is higher than that of students using conventional learning and discovery. Thus, there is a significant influence between the use of the Treffinger model and students' mathematical creative thinking ability, with an effect size of 1.02 which is classified in the large influence category.

The analysis's findings, which indicate that there are no papers with a weak effect size, support the idea that the Treffinger learning model significantly improves students' capacity for mathematical creativity. This result is consistent with constructivism, a theory made prominent by Piaget and Vygotsky, which holds that learning is an active process in which students build their knowledge through firsthand experience. With its problem-based learning methodology, the Treffinger model fosters creativity, engagement, and opportunity for students to delve deeply into mathematical ideas. In addition to learning the material, students develop critical thinking abilities through this process, which are crucial for overcoming many obstacles in the contemporary world.

Studies demonstrating large to extremely large effect size values attest to the Treffinger model's beneficial effects on the development of higher order thinking skills in addition to academic aptitude. Students may work together, think creatively, and solve challenging problems on their own thanks to the model's facilitation of student-centered learning. Students are inspired to become inventive and creative problem solvers through a method that incorporates constructivism theory. This is crucial for their academic achievement as well as for preparing them for obstacles in the future that call for a high degree of creativity, flexibility, and critical thinking.

CONCLUSION

Based on data analysis from seven articles, three effect size categories were found, namely medium, large, and very large. The t-test calculation results show $t_{hitung} = 110.4 > 1.96 = t_{tabel}$ which indicates rejection of H_0. That is, there is a significant difference between students who use Treffinger learning model and students who follow conventional learning in mathematical creative thinking ability. The average creative thinking ability of students in the Treffinger model is higher than conventional learning. This confirms that the Treffinger model has a significant effect on improving students' mathematical creative thinking skills, with an effect size of 1.02 which is included in the large category. Additionally, prior studies have demonstrated that the Treffinger model outperforms the discovery model in fostering mathematical creativity. With the help of the Treffinger model, which promotes creativity and inquiry, students can actively participate in their education and maximize their capacity for creative thought. This demonstrates that applying the Treffinger model can be a suitable tactic for enhancing mathematical creativity.

Several suggestions are made for upcoming educators and researchers in light of these findings. First, students' ability to think creatively about mathematics can be developed through the application of the Treffinger learning paradigm. Second, in order to maximize students' capacity for creative thought, educators are encouraged to integrate the Treffinger model with scientific, STEM, or problem-solving-based techniques. Third, by incorporating scaffolding elements or additional learning materials, the Treffinger model can be used more effectively to help students increase their capacity for creative thought. Students will benefit from this extra help during the learning process, which will help them develop their mathematical creativity more effectively. The limitation of this study lies in the relatively small sample size, so the results obtained do not fully reflect the wider population. Therefore, it is recommended that future studies use a larger sample size to increase the validity and generalizability of the findings.

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REFERENCE

Anzani, V., & Juandi, D. (2022). Meta-Analysis: The Effect of Problem-Based Learning Assisted GeoGebra Software on Students Mathematic Ability. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *6*(2), 1900–1907. https://doi.org/10.31004/cendekia.v6i2.1425

Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2009). *Introduction to Meta-Analysis*. John Wiley & Sons Ltd. https://doi.org/10.1002/9780470743386

Damanik, R. N., Sinaga, B., & Napitulu, E. E. (2021). Meta Analisis Pengaruh Model Pembelajaran Terhadap Kemampuan Berpikir Kreatif Matematis Siswa. *PARADIKMA Jurnal Pendidikan Matematika*, *14*(2), 65–70. https://doi.org/10.24114/paradikma.v14i2.32365

Dewi, N. S., & Juandi, D. (2023). Pengaruh Pendekatan Open-Ended Terhadap Kemmapuan Berpikir Kreatif Matematis: Systematic Literature Review. *Jurnal Pembelajaran Matematika Inovatif*, *6*(3), 1135–1150. https://doi.org/http://dx.doi.org/10.22460/infinity.v6i1.234

Glass, G. V. (2015). Meta-analysis at middle age: A personal history. *Research Synthesis Method*, *6*(3), 221–231. https://doi.org/https://doi.org/10.1002/jrsm.1133

Grant, J., & Hunter, A. (2006). Measuring inconsistency in knowledgebases. *Journal of Intelligent Information System*, *27*(2), 159–184. https://doi.org/https://doi.org/10.1007/s10844-006-2974-4

Hernandez, A. V., Marti, K. M., & Roman, Y. M. (2020). Meta-analysis. *CHEST*, *158*(1), S97–S102.

Lambertus, L., Salam, M., Rezkiati, R., Suhar, S., & Hasnawati, H. (2023). Developing Mathematical Creative Thinking (CT) Ability Students Through The Treffinger Learning Model (LM). *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *12*(1), 23–35. https://doi.org/10.24127/ajpm.v12i1.5432

Lestari, E., & Hadi, S. (2022). Implementation of The Treffinger Model Based STEM Approach to Students ' Creative Thinking Skill. *INSECTA: Integrative Science Education and Teaching Activity Journal*, *3*(1), 92–102.

Lestari, K. E., & Yudhanegara, M. R. (2017). *Penelitian Pendidikan Matematika*. Refika Aditama.

Maharani, R. K., & Indrawati, D. (2018). Pengaruh Model Pembelajaran Treffinger Terhadap Kemampuan Berpikir Kreatif Pelajaran Matematika Materi Bangun Ruang. *Jurnal Penelitian Pendidikan Guru Sekolah Dasar*, *6*(4), 506–515.

Munandar, U. (2012). *Pengembangan Kreativitas Anak Berbakat*. Rineka Cipta.

Muslich, M. (2007). *Kurikulum Tingkat Satuan Pendidikan* (2nd ed.). PT. Bumi Aksara.

Ndiung, S., Sariyasa, Jehadus, E., & Apsari, R. A. (2021). The Effect of Treffinger Creative Learning Model with the Use RME Principles on Creative Thinking Skill and Mathematics Learning Outcome. *International Journal of Instruction*, *14*(2), 873–888. https://doi.org/10.29333/iji.2021.14249a

Nursamira, Hermansyah, S., & Susanti, D. (2023). Studi Literatur: Kemampuan Berpikir Kreatif Matematis Siswa. *Mathematics Education and Aplication Journal (META)*, *4*(2), 44–55. https://doi.org/10.35334/meta.v4i2.3347

Nursilawati, I., Nurkhimayati, I., & Santoso, E. (2019). Model Pembelajaran Treffinger untuk Meningkatkan Kemampuan Berpikir Kreatif Matematis Siswa. *Seminar*

Nasional Pendidikan, *FKIP UNMA*, 127–133.
Panjaitan, S. M. (2020). Upaya Meningkatkan Kemampuan Berfikir Kreatif Peserta Didik dengan Pembelajaran Konstektual Humanistik. *SEPREN: Journal of Mathematics Education and Applied*, *1*(2), 68–77. https://doi.org/10.36655/sepren.v1i02.222
Pigott, T. D. (2012). *Advances in Meta-Analysis* (1st ed.). Springer. https://doi.org/10.1007/978-1-4614-2278-5
Rifa, R., Sujana, A., & Romdonah, I. (2020). Penerapan Model Pembelajaran Treffinger untuk Meningkatkan Kemampuan Berpikir Kreatif Matematis Siswa. *Jurnal Analisa*, *6*(1), 1–9. https://doi.org/10.15575/ja.v6i1.4365
Rochaya, M., Fatah, A., & Rafianti, I. (2019). Pendekatan Pemecahan Masalah dalam Setting Model Treffinger Terhadap Kemampuan Berpikir Kreatif dan Kejujuran. *Seminar Nasional Penelitian Pendidikan Matematika (SNP2M) 2019 UMT*, 190–197.
Shadiq, F. (2014). *Pembelajaran Matematika; Cara Meningkatkan Kemampuan Berpikir Siswa* (1st ed.). Graha Ilmu.
Sunita, N. W. (2020). Pengaruh Model Pembelajaran Treffinger Terhadap kemmapuan Berpikir Kreatif dengan Mengontrol Adversity Quotient. *Widyadari: Jurnal Pendidikan*, *21*(2), 627–639. https://doi.org/10.5281/zenodo.4049422
Tania, N., Mariani, S., Agoestanto, A., & Susilo, B. E. (2024). Meta-Analysis: The Effect of Mathematical Resilience to Mathematical Problem Solving Ability. *SJME(Supremum Journal of Mathematics Education)*, *8*(1), 115–128. https://doi.org/10.35706/sjme.v8i1.10481
Torrance, E. P. (1974). The torrance tests of creative thinking: norms-technical manual. Princeton. *Personal Press*.
Treffinger, D. J., Young, G. C., Selby, E. C., & Cindy Shepardson. (2002). Assessing Creativity: A Guide for Educators. *Center for Creative Learning*.
Wardani, N. P. C., Sariyasa, & Marhaeni, A. A. I. N. (2017). Pengaruh Model Pembelajaran treffinger Berpendekatan Saintifik Terhadap Kemampuan Berpikir Kreatif Ditinjau dari Gaya Kognitif Siswa. *PENDASI: Jurnal Pendidikan Dasar Indonesia*, *1*(1), 1–11.