

## Meta-Analysis: The Effect of The Think Talk Write Learning Model on Students' Mathematics Learning Outcomes

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### Abstract

Students' low mathematics learning outcomes remain a major issue in education, highlighting the need for more effective and innovative instructional strategies. This study aims to explain the effect of Think Talk Write learning model on learning outcomes through the use of meta-analysis. This study presents a comprehensive meta-analysis to address the limitations of previous studies, which were largely contextual and lacked a thorough quantitative overview of the effectiveness of the Think Talk Write model on students' mathematics learning outcomes. This article quantitatively analyzes the effect of the Think Talk Write model, provides a description of the data on sample size, mean, and standard deviation, and is published in a Google Scholar indexed journal. In this analysis, mean difference, Forrest plot, and publication bias were calculated using JASP software and Excel manual calculation. The results of the analysis showed that the value of  $I^2 = 94.441$  with a confidence of 0.95%. The forest plot showed a mean effect of 1.39, and the study effect size values ranged between 0.76 and 2.01. This shows that there is a significant difference between learning with the Think Talk Write model and conventional learning. In the group learning process, students who used the Think Talk Write model had better learning outcomes than students who did not use it. The analysis shows that Think Talk Write model is very important to support learning.

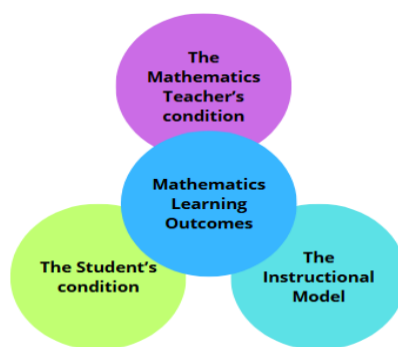
**Keywords:** Think Talk Write, Learning Outcomes, Meta-Analysis.

### Introduction

Education plays a crucial role as the foundation of human life. Its primary goal is to maximize each individual's potential and provide them with the opportunity to live a prosperous and dignified life (Hutagalung, H. S. M., Simbolon, H., & Sauduran, 2022). Education and learning are two interconnected components in building a person's scientific foundation and skills. In order to produce high-quality students, quality instruction must be applied during learning activities and implemented effectively and correctly (Batennie, 2021). Learning is a dynamic process in which students engage with various subjects to improve their understanding and skills in specific fields. Mathematics is one of the subjects that requires particular attention in efforts to enhance the overall quality of education (Simangunsong, W. M., Pasaribu, E., & Yanti, 2023).

Mathematics is a highly essential subject in education and must be taught from elementary through to higher education. Mathematics is not only significant in academic contexts but also in everyday life, as nearly every human activity is linked to mathematical concepts. However, many students show little interest in learning mathematics due to the

perception that it is a difficult subject. Mathematics is abstract, theoretical, and full of symbols and formulas that can be confusing, often leading to negative perceptions when the learning experience is not engaging or enjoyable (Mulyana et al., 2022). Despite these challenges, mathematics continues to evolve alongside the demands of the times, encouraging more creative approaches to its development and application as a foundational science that supports other disciplines (Early et al., 2018). Mathematics is a field of study that enables deep conceptual understanding, yet often struggles with ineffective teaching models that do not align with students' learning needs, resulting in poor academic performance. Three key factors underlie poor mathematics learning outcomes: the teacher's condition, the students' condition, and the instructional model used (Ramadhan, S., Mulyadin, E., 2021).

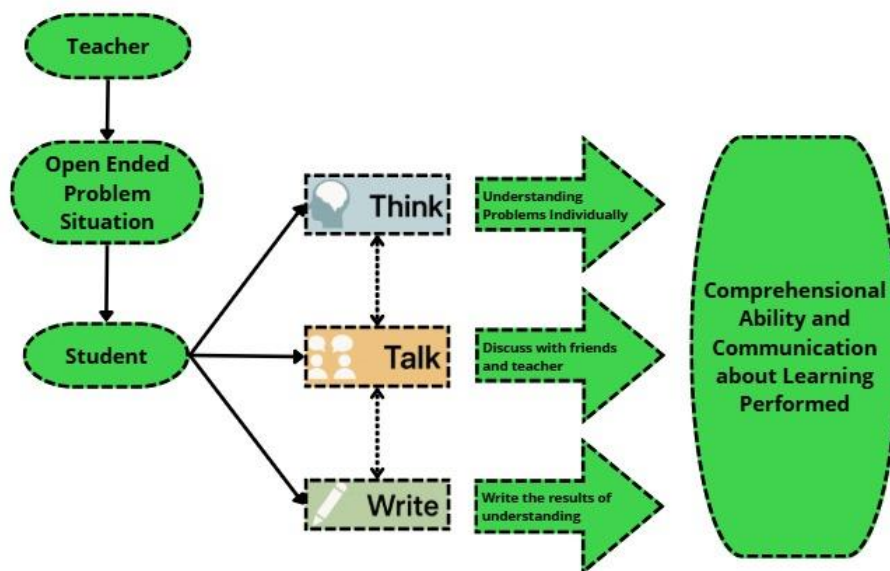


**Figure 1.** Factors Affecting Mathematics Learning Outcomes

Both internal and external factors contribute to poor student performance in mathematics. One significant external factor is the inadequacy of the mathematics learning process itself (Armila, A. S., Yahfizham, & Siregar, 2021). Learning outcomes refer to the knowledge and skills acquired by students as a result of engaging in educational experiences (Artika, Y., & Nasution, 2024). These outcomes are achieved through a learning process and are essential for evaluating how effectively knowledge has been acquired. Moreover, the incompatibility of instructional models with the nature of mathematics education is another reason students tend to have poor outcomes in this subject (Amir, N., & Nursakiah, 2022). Learning outcomes serve to assess the success of academic goals achieved during the instructional process and must be aligned with educational objectives (Zalmonetasari & Reinita, 2021).

In the current educational era, it is critical to develop and implement innovative instructional methods that enhance student achievement, comprehension, and mathematical skills. Cooperative learning is one such approach believed to effectively foster active

student participation during the learning process (Susanto, 2020). The Think Talk Write (TTW) cooperative learning model, developed by Huinker and Laughlin, is among the instructional models that can address this issue. TTW integrates three core components: thinking (Think), discussing (Talk), and writing (Write). According to Mu'alifah, Satianingsih, R., & Yustitia (2020), the TTW model is designed to help students think independently, engage in discussions with peers or in groups, and write down the ideas generated from these processes. When implemented, the TTW model offers several advantages. As outlined by Shoimin (2016), these include: 1) promoting meaningful understanding of the subject matter, 2) enhancing critical and creative thinking skills through open-ended problems, 3) encouraging active student engagement through group interaction and discussion, and 4) cultivating students' abilities to think and communicate effectively with others, including teachers, peers, and themselves.



**Figure 2.** Illustration of the Think-Talk-Write (TTW) Learning Model

Given its popularity and the considerable number of studies supporting its effectiveness in mathematics education, there is a need for a comprehensive meta-analysis that integrates and evaluates empirical findings from recent years. This meta-analysis aims to systematically determine the effectiveness of the Think Talk Write model in improving students' mathematics learning outcomes. The analysis will consider variables such as educational context, grade level (elementary, junior high, and senior high school), and variations in student performance. Beyond identifying patterns and trends, this article will critically analyze available data to offer valuable insights for educators and education

policymakers. Therefore, this study seeks to examine the impact of the Think-Talk-Write learning model on students' academic performance.

The approach used in this research involves calculating the effect size and conducting a meta-analysis of several articles published via Publish or Perish 8. The effect size of each article is calculated to assess the magnitude of the influence or effectiveness of the Think-Talk-Write method on student learning outcomes. Effect size is defined as a quantitative index used to summarize research findings in a meta-analysis (Jeremia et al., 2020). Thus, this study is expected to provide robust scientific evidence either supporting or challenging the success of the Think-Talk-Write model in mathematics instruction.

## **Method**

This study employed a meta-analysis method. Meta-analysis is a method that examines several articles published in national and international journals. It is a type of research used by researchers to summarize, review, and analyze research data based on previous findings (Anugraheni, 2018). In line with the opinion of Glass (Amin et al., 2020), meta-analysis is an analysis of various statistical analyses that aims to integrate conclusions derived from a collection of analytical results from multiple studies. Meta-analysis involves numerical and statistical calculations for practical purposes and is therefore quantitative in nature, aiming to extract and organize information from a large number of articles that cannot be feasibly processed using other methods (Anggreni et al., 2019). As research involving similar variables continues to grow each year, this method helps answer questions regarding differences between experimental and control groups. Meta-analysis presents research findings using a comparative influence measure known as effect size. This is conducted to examine whether the research results are consistent, as a greater number of similar studies tend to produce more variations in outcomes.

The data analysis technique used in this study aims to measure how significant a finding is in practical terms, not just statistically, by comparing the magnitude of the effect size of the Think Talk Write learning model on students' learning outcomes. Inclusion criteria refer to conditions that must be met for a population to be included in the sample, while exclusion criteria are the conditions that disqualify data from being used in the study (Laili et al., 2023). In this meta-analysis research, data were first collected by sourcing articles from digital platforms such as Google Scholar and Publish or Perish 8. The data analysis was performed manually using Microsoft Excel and the JASP application.

The data collection criteria applied in selecting articles for this study were as follows: articles were authored by general researchers or students, published within the last six years (2019–2024), used the Think Talk Write model as the independent variable, employed students’ learning outcomes as the dependent variable, and covered educational levels ranging from elementary to senior high school. Based on these criteria, 17 articles were deemed eligible for analysis. The subsequent technical analysis was conducted as follows (Samritin, 2023). The estimation of the average sample effect size ( $d$ ) was standardized using the following equation:

$$d = \frac{\bar{X}_1 - \bar{X}_2}{S_{within}} \quad 1$$

$$S_{within} = \sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{(n_1 - 1) + (n_2 - 1)}} \quad 2$$

The formula for calculating the standard error ( $SE_d$ ) is:

$$SE_d = \sqrt{V_d} \quad 3$$

$$V_d = \frac{n_1 + n_2}{n_1 n_2} + \frac{d^2}{2(n_1 + n_2)} \quad 4$$

To minimize bias, the following formula is used:

$$g = J \times d \quad 5$$

$$J = 1 - \frac{3}{4df - 1} \quad 6$$

$$df = \text{degree of freedom} = n_1 + n_2 - 2 \quad 7$$

$$SE_g = \sqrt{V_g} \quad ; \quad V_g = J \times V_d \quad 8$$

The method for calculating the effect size for each article is as follows (Nugroho et al., 2020):

$$ES = \frac{\bar{x}_E - \bar{x}_c}{SD_C} \quad 9$$

Explanation:

$ES$  = Effect Size commonly denoted as  $\alpha$  or  $\Delta$ )

$\bar{x}_E$  = Mean of the experimental group

$\bar{x}_c$  = Mean of the control group

$SD_C$  = Standard deviation of the control group

**Table 1.** Effect Size Assessment Criteria

No.	Intervals	Criteria
1.	$ES \leq 0,15$	Ignored
2.	$0,15 < ES \leq 0,40$	Small
3.	$0,40 < ES \leq 0,75$	Medium
4.	$0,75 < ES \leq 1,10$	High
5.	$1,10 < ES \leq 1,45$	Very High
6.	$ES > 1,45$	Excellent

Adapted from Juandi et al (2021)

Based on Table 1 above, the range  $0.75 < ES \leq 1.45$  can be concluded to indicate that this category has a significant impact from the Think Talk Write learning model.

### Results and Discussion

The data were collected by gathering articles published on Google Scholar using the Publish or Perish 8 application. A total of 17 publications were evaluated based on the information gathered through a Google Scholar search. The keywords used in the title word field were *Think Talk Write* and *learning outcomes*. Table 2 presents the classification results of the publications based on the level of education, independent variables, and dependent variables.

**Table 2.** Classification of Article Analysis Data

Type of Analysis	Article Output	Number of Analyses
Education Level	Elementary School (SD/MI)	3
	Junior High School (SMP)	9
	Senior High School/Vocational (SMA/SMK)	5
Dependent Variable	Learning outcomes	17
Independent Variable	Think Talk Write (TTW) Model	17

The extraction of statistical data from the coding of 17 primary research studies is presented in Table 3.

**Table 3.** Data Extraction Results

No.	Study	Experimental Group			Control Group		
		N	M	SD	N	M	SD
1	(Triana et al., 2019)	28	78,43	8,49	30	68,77	10,95
2	(Lubis, 2019)	21	77,43	10,50	23	74,30	10,67
3	(Sinaga, 2019)	30	63,8	3,03	30	46	2,84
4	(Mu'alifah, Satianingsih, R., & Yustitia, 2020)	36	82,56	8,93	36	76,45	11,08
5	(Oni & Rahmatia, 2020)	16	84,88	5,4	16	80,25	5,85
6	(Ramadhan, S., Mulyadin, E., 2021)	36	81,94	1,69	36	82,5	1,55
7	(Zalmonetasari & Reinita, 2021)	29	80,68	8,07	29	68,41	10,55
8	(Armila, A. S., Yahfizham, & Siregar, 2021)	30	70,73	10,95	30	62,56	11,97
9	(Batennie, 2021)	28	77,93	9,97	28	77,68	10,41
10	(Amir, N., & Nursakiah, 2022)	15	82,53	3,44	15	78,73	2,02
11	(Hutagalung, H. S. M., Simbolon, H., & Sauduran, 2022)	32	75,64	4,64	32	70,6	4,45
12	(RISMAWATI, 2022)	15	84,85	21,38	15	69,05	22,41
13	(Agustin, 2022)	18	82,77	20,02	20	76,75	23,46
14	(Simangunsong, W. M., Pasaribu, E., & Yanti, 2023)	23	77,61	11,76	23	48,91	20,51
15	(KHOEROH, 2023)	30	79,79	9,09	30	71,67	10,85
16	(Amalafitra et al., 2023)	34	71,03	3,49	34	63,24	3,66
17	(Artika, Y., & Nasution, 2024)	32	70,47	12,54	31	62,87	13,37

Explanation:

N : Number of samples in each study

M : Mean score of each study

SD : Standard deviation in each study

Based on Table 3 above, it can be observed that the extracted data from studies meeting the inclusion criteria include several key pieces of information, such as the number of samples, standard deviation of each group, and the average post-test scores for both the *Think Talk Write* learning model and the conventional model. The summarized research articles were then analyzed by calculating the average *effect size* scores. The effect size values are used to describe the extent of the influence of the *Think Talk Write* model on students' mathematics learning outcomes. The average influence scores from the measurements are presented in Table 4.

**Table 4.** Effect Size of the Articles

Code	$g$	$V_g$	$SE_g$	Effect Size Category
A1	1,53	0,09	0,30	Excellent
A2	0,41	0,09	0,30	Medium
A3	5,66	0,34	0,58	Excellent
A4	0,90	0,06	0,25	High
A5	1,08	0,14	0,37	High
A6	-0,37	0,06	0,24	Ignored
A7	1,97	0,10	0,32	Excellent
A8	0,99	0,07	0,27	High
A9	0,03	0,07	0,27	Ignored
A10	1,40	0,16	0,40	Very High
A11	1,38	0,08	0,28	Very High
A12	0,99	0,15	0,38	High
A13	0,42	0,11	0,33	Medium
A14	3,17	0,20	0,44	Excellent
A15	1,17	0,08	0,28	Very High
A16	2,74	0,11	0,34	Excellent
A17	0,81	0,07	0,26	High

Explanation:

$g$  : Effect Size - a statistical measure used to summarize findings in meta-analysis. The magnitude of  $g$  reflects the strength of the relationship or impact observed in each study.

$V_g$  : Variance - indicates the dispersion of the effect size within each study.

$SE_g$  : Standard Error - used to estimate the confidence interval of the effect size, indicating the precision of the measurement.

Furthermore, the results of the heterogeneity test, where the value of  $I^2 > 25\%$ , are presented in Table 5 as follows:

**Table 5.** Results of Heterogeneity Test

Fixed and Random Effects			
	Q	df	p
Omnibus test of Model Coefficients	18.933	1	< .001
Test of Residual Heterogeneity	182.978	16	< .001
<i>Note.</i> $p$ -values are approximate.			
<i>Note.</i> The model was estimated using Restricted ML method.			

The results of the analysis indicate that the 17 effect sizes analysed are heterogeneous ( $Q = 182.978; p < 0.001$ ). This suggests that the variability among studies is greater than would be expected by chance alone. Therefore, a random effects model is more appropriate for estimating the average effect size across the 17 included studies.

**Table 6.** Estimation of Residual Heterogeneity

Residual Heterogeneity Estimates			
		95% Confidence Interval	
	Estimate	Lower	Upper
$\tau^2$	1.613	0.862	4.317
$\tau$	1.270	0.929	2.078
$I^2$ (%)	94.411	90.030	97.835
$H^2$	17.893	10.030	46.198

The research data must satisfy the heterogeneity assumption, as this study employs a random effects model. Accordingly,  $I^2$  is one of the statistical methods used to assess heterogeneity. The  $I^2$  statistic indicates the proportion of variability in the summary effect sizes, ranging from 0% to 100%. In this study, the use of the random effects model is justified based on the criterion that  $I^2 = 94.441\%$ , which is significantly greater than the 25% threshold, indicating substantial heterogeneity among the studies analysed. Furthermore, the overall effect size of the analyzed data can be visually interpreted using the Forest Plot, as shown in figure 3.

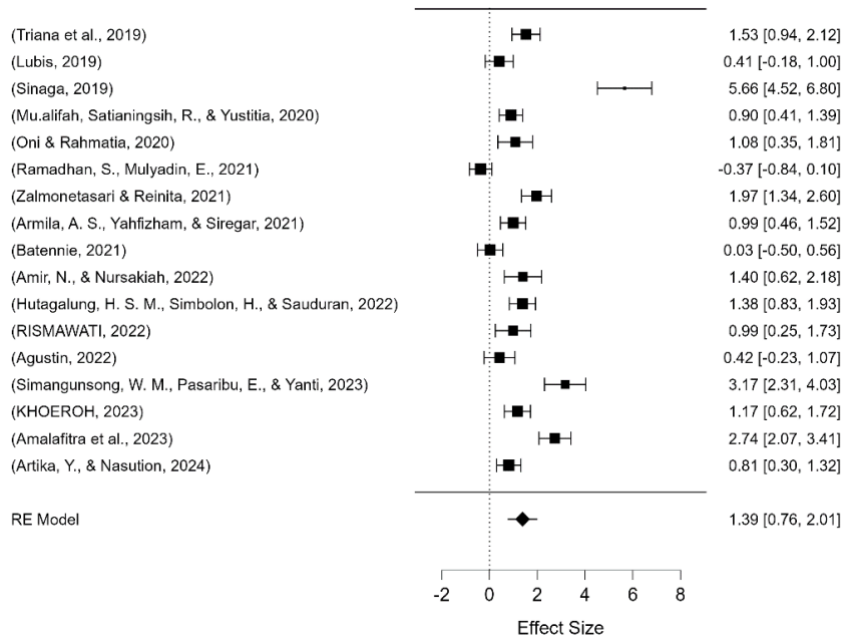


Figure 3. Forest Plot

The forest plot data shows an average effect size of 1.39, as illustrated in Figure 1. This means that the Think Talk Write learning model strongly influences students' mathematics learning outcomes. In addition, the range of effect sizes from the analyzed studies varies from 0.76 to 2.01, with a 95% significance level. This clearly indicates that the Think Talk Write model has a significant difference compared to the conventional learning approach.

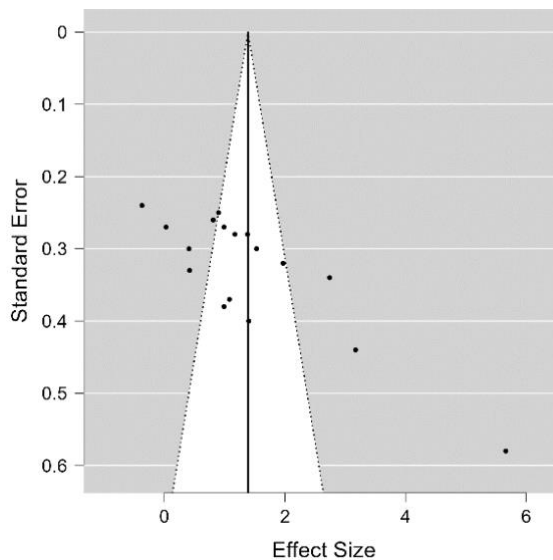


Figure 4. Funnel Plot

Based on the results shown in Figure 4, an Egger's test is required to determine whether the funnel plot is symmetrical, as the visual results alone are insufficient to conclude symmetry.

**Table 7.** File Drawer Analysis

File Drawer Analysis			
	Fail-safe N	Target Significance	Observed Significance
Rosenthal	1594.000	0.050	< .001

From Table 7,  $K = 17$ , so  $5K + 10 = 5(17) + 10 = 95$ . The Fail-safe N value obtained is 1594 with a significance level of 0.05 and  $p < 0.001$ . Since the Fail-safe N  $> 5K + 10$ , it can be concluded that there is no publication bias in this meta-analysis study.

This study examines the effectiveness of the Think Talk Write learning model on students' mathematics learning outcomes in Indonesia. Based on the meta-analysis conducted, it was found that compared to conventional teaching models, the Think Talk Write model has a significant impact on students' learning outcomes. From the 17 primary studies analyzed, all studies showed that the Think Talk Write model had a significant positive effect on students' mathematics learning outcomes. The analysis revealed five studies with a "very good" category, three studies with a "very high" category, five studies with a "high" category, two studies with a "moderate" category, and two studies categorized as "ignored." A key factor in meta-analysis is effect size because it summarizes the outcome data from the analysis (Turmuzi, 2022). From the research data, the forest plot shows that the average effect size of the meta-analysis is 1.38, which falls into the "very high" category (Juandi et al., 2021). This indicates that the use of the Think Talk Write model consistently improves students' learning outcomes with a high level of effectiveness. This conclusion is supported by research (Oni & Rahmatia, 2020), which states that the Think Talk Write model has a significant effect on students' mathematics learning outcomes. Another relevant study (Kusuma et al., 2020) concluded that the Think Talk Write model is the most effective teaching model for mathematics compared to Think Pair Share and Problem-Based Instruction.

The improvement in students' mathematics learning outcomes when using the Think Talk Write model means that the learning process becomes more meaningful, and students will be more motivated to engage in learning, making it easier for them to master the material presented. According to the meta-analysis, all levels of education can improve student learning outcomes, even though sample sizes differ in the application of the cooperative learning model Think Talk Write. Many researchers have discussed the Think Talk Write model. In addition to improving learning outcomes, the Think Talk Write model also has a greater impact on enhancing students' mathematical communication skills (Putri et al., 2022), mathematical problem-solving skills (Jeremia et al., 2020), critical

thinking and mathematical communication skills (Nasrulloh & Umardiyah, 2021), critical thinking skills (Ainin et al., 2020), as well as mathematical reasoning and learning independence (Maulana et al., 2020). Given these findings, the Think Talk Write model deserves attention for its potential application in mathematics education.

The results of this meta-analysis contribute significantly to the development of knowledge, particularly in the field of mathematics education. This study proves that the Think Talk Write model is effective and can significantly improve students' learning outcomes. Mathematics learning outcomes play a crucial role as they serve as indicators of the effectiveness and success of the instructional process that has been implemented (Ulfiyati et al., 2025). The implication of this meta-analysis is that educators can modify or enhance their teaching strategies using the Think Talk Write model. If the Think Talk Write model proves to be effective, schools may adopt it more broadly to enhance students' understanding of mathematical concepts. The findings of this study can reinforce or challenge existing theories on active learning and cooperative learning. It offers new insights into how speaking and writing activities can improve mathematical understanding. Therefore, educators and policymakers in Indonesia should consider adopting the Think Talk Write model as a primary strategy in mathematics instruction. Given its proven effectiveness, this approach can be a powerful tool to improve students' mathematics learning outcomes.

### **Conclusion and Suggestion**

This study investigates the effectiveness of the Think Talk Write (TTW) learning model in improving students' mathematics learning outcomes. By integrating and analyzing the results of 17 published studies, the study employs meta-analysis to measure the impact of TTW on students' mathematical understanding and skills. The findings indicate that TTW, which combines thinking, talking, and writing elements, significantly enhances mathematics learning outcomes. Specifically, the study reveals that the TTW model is effective in improving students' mathematical understanding across various educational levels, from elementary school to high school. This conclusion supports the broader implementation of the TTW model in mathematics instruction, suggesting that this approach can serve as a key strategy in mathematics education to motivate students and deepen their conceptual understanding.

Based on the findings of this study, it is recommended that educators and education policymakers optimize the use of the TTW learning model in mathematics instruction, particularly to enhance student learning outcomes. Given that this model has proven effective in encouraging active student participation, improving critical thinking skills, and fostering more meaningful learning experiences, it is crucial to continue developing and promoting this method across various educational levels. Furthermore, further research is needed to explore the potential application of the TTW model in broader educational contexts, taking into account the variation in student characteristics and differences in educational levels, so that its implementation can be more effective and tailored to meet the needs of each student group.

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