



Measuring Students' Success in Mathematics Learning Through Meta-Analysis of Numbered Heads Together Effectiveness

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ABSTRACT

This study aims to measure students' success in mathematics learning based on the achievement of the Minimum Mastery Criteria (MMC) as a result of the implementation of the Numbered Heads Together (NHT) model. This study applied a meta-analysis method, involving 21 primary studies from elementary school to upper school. The research data was collected using the Google Scholar database with the help of the Publish or Perish application. The data was analyzed with the help of the Jamovi application. The effect size interpretation refers to Cohen's classification with a p-value < 0.05. Data heterogeneity testing using Q and I² statistics. Based on the analysts' results, it was found that the mathematics learning outcomes did not have significant variance as indicated by the probability of Q₁ and Q₂, respectively, p = 1,000 and I² = 0.000. The results of the analysis using a fixed model were obtained, SES₁ = 0.557 with p < 0.005 and SES₂ = 0.834 with p < 0.05, which shows the significance of the effectiveness of NHT on the mathematics learning success. Based on the results of the analysis, this study concludes that the application of the NHT model has a significant and consistent influence on the success of mathematics learning at all levels of education.

INTRODUCTION

The success of student learning since the implementation of the 2006 curriculum is measured based on the achievement of the Minimum Mastery Criteria (MMC). MMC is the lowest score that students must obtain to be declared successful or fail. Students who reach or exceed the MMC are declared successful, while others are declared failures, so they have to repeat (Guskey, 2015; Schwartz et al., 2022). The more successful students indicate that the learning carried out is getting better, and vice versa. To encourage the improvement of student learning, various efforts must be applied, including feedback and the implementation of innovative learning models (Wisniewski et al., 2020).

The achievement of the mathematics MMC is the main benchmark for the success of mathematics learning in cognitive aspects. Mathematics encourages logical, analytical, and systematic thinking skills (Abo-Romi, 2020; Aragón et al., 2024; Cirik & Akpolat, 2024; Öz & Çiftci, 2024), and creative thinking (Johnson & Smith, 2023; Jonsson et al., 2022; Smit et al., 2023; Vale et al., 2017). However, in the field, it is often found that students have not reached the Minimum Mastery Criteria (MMC) standard in mathematics subjects. This condition shows that mathematics learning still needs to be improved (Hattie & Clarke, 2019). Therefore, an in-depth study is needed on the effectiveness of the learning strategies applied (Boaler et al., 2021; Savelsbergh et al., 2016).

The Numbered Heads Together (NHT) model is one of the types of cooperative learning that is often used to improve mathematics learning outcomes (Gillies, 2016). NHT is based on social constructivism that emphasizes the importance of social interaction and dialogue to build common knowledge (Dennick, 2016; Erbil, 2020). The principle of positive dependency is reflected in small group work, where the success of each individual also determines the success of the group as a whole, as affirmed in the theory of social interdependence (Gillies, 2016; Shimizu et al., 2020). In NHT, individual accountability is maintained through the provision of head numbers so that each student has a personal responsibility to understand the material, in line with the finding that the success of cooperative learning is highly determined by the balance between group responsibility and personal roles (Nguyen & Oanh, 2025; Zhou & Colomer, 2024).

Numbered Head Together is a group learning model where each member is responsible for his or her group assignments so that there is no separation between one student and another in a group to give (Haydon et al., 2019) and receive from each other (Kaldırım & Tavşanlı, 2018). A distinctive feature of this model is the giving of a head number to each member of the group. Cooperation in NHT small groups allows for student involvement. Through group cooperation, students help each other and encourage each other to understand the subject matter (Kaldırım & Tavşanlı, 2018; S. Kaymak et al., 2021). In addition, the use of head numbers during the evaluation of group work results greatly allows students to spur their enthusiasm for learning because they are trained to be responsible and strive to be the best (Boke et al., 2025; Gull & Shehzad, 2015). Thus, this model can provide a pleasant learning atmosphere and maximize

student involvement, which involves emotional and intellectual aspects (Ranak, 2016).

Many classroom action studies have applied the NHT Model to improve math learning outcomes. The NHT model is claimed by many studies as one of the learning models that can encourage improvement in mathematics learning outcomes (Erwahyuni, 2023). These studies were conducted at the elementary school level to the secondary school level. The NHT Model Numbered Heads Together (NHT) model is reported to be effective in improving learning outcomes at the elementary school level (Asmoro et al., 2023; Mangundap et al., 2023). The results of research at the junior high school level are also reported to be effective in improving mathematics learning outcomes (Hamdani, 2021; Simarmata et al., 2023; Sinaga & Sitepu, 2021). Although very limited, efforts to improve mathematics learning outcomes at the high school level using the NHT model have also been carried out and reported to be effective (Faizah, 2019; Indrawati, 2023; Nurlaila, 2022).

Although these studies reported that the implementation of the NHT model was effective in increasing the success of mathematics learning, the percentage of MMC achievement varied with the number of study subjects, also varying. In addition, the results of CAR are not statistically analyzed, so the results cannot be generalized. Therefore, a meta-analysis is needed that can analyze the effects of several studies to obtain a measure of success rates simultaneously. Synthesizing the results of classroom action research (PTK) is also important because it can reveal patterns of intervention effectiveness that are consistent across multiple contexts so as to provide a stronger empirical basis for learning practices. Meta-analysis is a method of data synthesis to produce a strong generalization of findings from various studies (Gracia & Anugraheni, 2021; Widiyanti et al., 2024). Meta-analyses in Indonesia, in general, have highlighted cooperative learning models (Amin et al., 2020; Rahmandani et al., 2022), but the NHT model has not been analyzed. In particular, the meta-analysis of the effects of NHT from CAR has not been carried out by previous research, so this study is very important to be conducted. The question answered in this study is how strong the effectiveness of the implementation of the NHT model is in increasing the success of learning mathematics? The purpose of this study is to measure the effectiveness of the NHT model in improving mathematics learning outcomes based on MMC achievements through CAR meta-analysis at the elementary, junior high, and high school levels. The results of this research are expected to be useful for the development of science and mathematics learning practices to improve student learning outcomes in the classroom.

METHOD

Research Design

This study uses a meta-analysis approach to assess the effectiveness of the Numbered Heads Together (NHT) learning model on the achievement of mathematics learning outcomes, which is reviewed from the proportion of students who achieve the Minimum Mastery Criteria (MMC) in each cycle of Classroom Action Research (CAR). This study examines the effectiveness of the

influence of the NHT model and measures the quantification of effectiveness based on real data on the increase in students who achieve the MMC, so that it is more representative of the context of mathematics learning in the field.

Research Strategy

The population studied was all publications of CAR results in mathematics learning that applied the NHT model. The samples used were all publications that met the inclusion criteria. Data is collected through the Google Scholar database using the Publish or Perish (PoP) application as a search tool. Data search using a maximum limit of 200 articles. The selection of articles is done by reading the entire text. From the screening/selection process, 21 studies were obtained as samples that are suitable for quantitative analysis (see Table 1).

Inclusion Criteria

The inclusion criteria in the study selection include: (1) CAR results that use the NHT learning model in mathematics lessons; (2) The study presents the number of samples as well as the proportion or number of students who reached the MMC in cycle I and cycle II; (3) Primary school (PS), junior high school (JHS), and high school (HS); (4) The study was published in the 2019–2024 range; and (5) The study was published through journals. All publications that did not meet the inclusion criteria were not included in the analysis.

Table 1. Data Sample

No	Author (date)	Level	N	T1	P1	T2	P2
1	Wahyuningsih et al. (2024)	PS	24		62.50%		85.00%
2	Widiasari (2024)	PS	10	3	30.00%	8	80.00%
3	Fatma et al. (2023)	PS	22	15	68.18%	18	81.82%
4	Safitri et al. (2024)	PS	20	10	50.00%	16	80.00%
5	Asmoro et al. (2023)	PS	27		63.00%		89.00%
6	Mangundap et al. (2023)	PS	34	15	44.00%	31	91.00%
7	Erwahyuni (2023)	JHS	30	17	56.67%	26	86.67%
8	Firdaus et al. (2024)	JHS	32	23	71.88%	28	87.50%
9	Simarmata et al. (2023)	JHS	30	18	60.00%	24	80.00%
10	Wijaya et al. (2023)	PS	14	7	50.00%	12	85.71%
11	Ardhika et al. (2023)	PS	38	17	44.74%	32	84.21%
12	Indrawati (2023)	HS	36		66.00%		78.00%
13	Slamet et al. (2020)	PS	28	14	50.00%	20	71.43%
14	Nurlaila (2022)	HS	36	23	64.00%	30	83.33%
15	Asminingrum (2022)	JHS	33	16	48.00%	23	69.70%
16	Adawiya (2022)	JHS	25	11	44.00%	22	88.00%
17	Hamdani (2021)	JHS	37	23	62.00%	32	86.49%
18	Murtalib et al. (2020)	JHS	31	20	65.00%	25	80.65%
19	Ikhwandari et al. (2019)	PS	23	15	65.00%	20	86.96%
20	Arisandy et al. (2019)	PS	20	8	40.00%	14	70.00%
21	Faizah (2019)	HS	34		47.06%		88.23%

Data Analysis

All sample data is extracted and analyzed using the Jamovi application. The effect size (ES) and standard error (SE) of each study were calculated based on the proportion of students who completed or the percentage of students who achieved MMC in each cycle. The conversion of the MMC achievement into effect size (ES) is calculated using the proportion of students who complete to the total number of students. For studies that do not include the number of students who are complete, the ES is deducted from the percentage of students who are completed, divided by 100%. Mathematically, the formulas used to calculate the effect size (ES) and standard error (SE) of each study are:

$$ES = k = \frac{T}{N} = \frac{P}{100\%};$$

$$SE = \sqrt{\frac{k(1-k)}{N}};$$

The measure of the success of learning mathematics as a result of NHT implementation is based on the conversion of the effect size into the Cohen category. Cohen (1988) suggested that ES was about 0.2 = small effect, 0.5 = medium, and 0.8 = strong. Furthermore, the interpretation of the Summary effect size (SES) was strengthened with a p-value at a 95% confidence interval. To test the heterogeneity of the study set, statistical values Q and I² were used. If $p > 0.05$, then the variance is not heterogeneous, and a fixed model is used; if $p < 0.05$, then the variance effect size is heterogony and the random effects model is used. As a test for the potential bias of publications, the Funnel Plot, Fail-safe N, and Egger's Regression methods were used. A high Fail-safe value of N indicates stable and unbiased analysis results. If the FSN value is greater than $5k + 10$, for k is many publications analyzed, then publication bias does not exist (Rosenthal, 1979). The overall stage of this meta-analysis process is visualized in Figure 1.

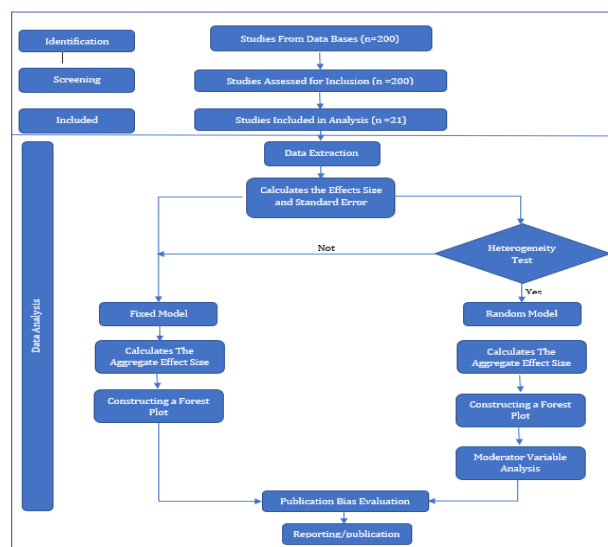


Figure 1. Meta-analysis Process

RESULT AND DISCUSSION

Effect Size and Standard Error of Each Study

All studies that met the inclusion criteria were calculated for effect size (ES) and standard error (SE) in each cycle. Table 2 presents the results of the calculation of effect sizes of cycle I (ES₁), effect size cycle II (ES₂), and standard error cycle I (SE₁) and standard error cycle 2 (SE₂) from 21 studies included and their respective categories.

Table 2. Effect Size and Standard Error of Studies

No	Author	N	ES ₁	Category	SE ₁	ES ₂	Category	SE ₂
1	Wahyuningsih et al.	24	0.6250	Strong	0.0988	0.8500	Strong	0.0729
2	Widiasari	10	0.3000	Midle	0.1449	0.8000	Strong	0.1265
3	Fatma et al.	22	0.6818	Strong	0.0993	0.8182	Strong	0.0822
4	Safitri et al.	20	0.5000	Midle	0.1118	0.8000	Strong	0.0894
5	Asmoro et al.	27	0.6300	Strong	0.0929	0.8900	Strong	0.0602
6	Mangundap et al.	34	0.4400	Midle	0.0851	0.9100	Strong	0.0491
7	Erwahyuni	30	0.5667	Strong	0.0905	0.8667	Strong	0.0621
8	Firdaus	32	0.7188	Strong	0.0795	0.8750	Strong	0.0585
9	Simarmata et al.	30	0.6000	Strong	0.0894	0.8000	Strong	0.0730
10	Wijaya et al.	14	0.5000	Midle	0.1336	0.8571	Strong	0.0935
11	Ardhika	38	0.4474	Midle	0.0807	0.8421	Strong	0.0592
12	Indrawati	36	0.6600	Strong	0.0790	0.7800	Strong	0.0690
13	Slamet et al.	28	0.5000	Midle	0.0945	0.7143	Strong	0.0854
14	Nurlaila	36	0.6400	Strong	0.0800	0.8333	Strong	0.0621
15	Asminingrum	33	0.4800	Midle	0.0870	0.6970	Strong	0.0800
16	Adawiya	25	0.4400	Midle	0.0993	0.8800	Strong	0.0650
17	Hamdani	37	0.6200	Strong	0.0798	0.8649	Strong	0.0562
18	Murtalib	31	0.6500	Strong	0.0857	0.8065	Strong	0.0710
19	Ikhwandari	23	0.6500	Strong	0.0995	0.8696	Strong	0.0702
20	Arisandy	20	0.4000	Midle	0.1095	0.7000	Strong	0.1025
21	Faizah	34	0.4706	Midle	0.0856	0.8823	Strong	0.0553

Based on Table 2, it appears that the effect size of each study has different effect sizes both in cycle I and in cycle II. The same goes for the standard error. However, based on the strength of the effect in the first cycle, the effect size can be mapped into 2 groups, namely 11 studies or 52.4% have a strong category, and 10 studies or 47.06% have a moderate effect. The results of the standard error calculation in cycle I obtained ES₁ from 0.5667 to 0.7188, with standard error (SE₂) in the range of 0.0790 to 0.1449. The results of the effect size analysis in the first cycle showed that the initial implementation of the NHT model had a fairly strong effect on the success of mathematics learning because none of the studies had a weak effect. Although all of these effect measures can be said to be quite good in the first cycle, the effect of the study in the medium category is still dominant.

The effect size listed in Table 2 shows that the lowest ES₂ in the cycle is in the strong category with a value of 0.697. Because the lowest effect size was in a strong category, from cycle I to cycle II there was a very large increase, namely all ES₂ (100%) were in a strong category, and all SE₂ decreased. This significant improvement can be understood as a measure of the success of NHT model interventions in the CAR cycle. The increase in all effect measures from cycle I

to cycle II indicates that the repetition of the CAR cycle has a strong influence on the achievement of the mathematics MMC. This provides evidence that the continuous application of the NHT model has a stronger effect.

Heterogeneity Test Results and Summary Effect Size

Heterogeneity and summary effect size tests were performed using the Jamovi application. The heterogeneity test is carried out to ensure the suitability of the analysis model. The summary effect size was analyzed to determine the combined size and strength of the effects from all primary studies included. The results of the heterogeneity test are presented in Table 3, and the summary effect size is presented in Table 4.

Table 3. Heterogeneity Statistics Tests

Cicle	I ²	df	Q	p
I	0%	20	2.442	1.000
II	0%	20	1.007	1.000

Table 3 presents the results of heterogeneity analysis in the two implementation cycles based on two statistical indicators. It appears that in both cycles, the I² value is 0%, which means that no heterogeneity is detected in the data. Methodologically, the I² value is used to measure the proportion of total variation caused by real differences between studies, rather than by chance factors (Borenstein et al., 2009). If the I² value is close to 0%, then almost all variations that appear in the data can be explained by sampling errors, so there are no significant differences between studies (Higgins et al., 2003). In other words, the similarity of results between primary studies analyzed in this meta-analysis shows the consistency of the effect of the NHT model on mathematics learning outcomes. Statistically, $Q_1 = 2,442 < df$ and $Q_2 = 1,007 < df$, and each had a value of $p = 1,000 > 0.05$, indicating that statistically, there was no significant variance heterogeneity in either cycle I or cycle II. The results of the I² analysis and Q statistics indicate that the data in cycles I and II have homogeneous variance, with no significant variance between groups. The results of this analysis indicate that the fixed model matches the data. Thus, the results of the analysis using the fixed model can be interpreted without the need to consider differences between subgroups, for example, between school levels or the number of CAR subjects. These findings corroborate the findings of several meta-analysis studies on the homogeneity of variance of cooperative learning models (Widyastuti & Rahayu, 2021).

Table 4. Summary Effect Size

	Cycle	Estimate	Se	z	p	CI Lower Bound	CI Upper Bound
Summary Effect Size	I	0.557	0.0666	8.36	<.001	0.426	0.687
	II	0.834	0.0577	14.5	<.001	0.721	0.947

In Cycle I, the estimated summary effect (SES) value was 0.557 with a standard error (SE) of 0.0666, resulting in a Z value of 8.36 and a p-value of < 0.001. This shows that the estimated effect size at this stage is in the category of strong and statistically significant. The 95% confidence interval (CI) for this

estimate is in the range of 0.426 to 0.687, which indicates a level of certainty that the actual value of the security is within that range. In Cycle II, the summary effect size (SES) estimate was increased to 0.834 with a smaller standard error of 0.0577, resulting in a Z of 14.5 and a p of $<.001$, which shows that the estimation results are in the strong and statistically significant category. The confidence interval for Cycle II was higher, at 0.721 to 0.947, indicating a stronger effect and a higher level of precision compared to the previous cycle. The increase in SES from cycle I to cycle II can be caused by the repetition of the learning process, which allows students to experience reinforcement and increased understanding. In addition, it can also be influenced by the improvement of the learning process carried out by teachers based on the results of their reflection on the learning process and results in cycle I.

The increase in the summary effect size (SES) estimation from 0.277 in cycle I to cycle II reflects a substantial increase in the magnitude of the effect of the intervention or treatment provided. In addition, the decrease in the standard error value of 0.009 and the increase in the Z value of 6.14 showed that the achievement of learning success in Cycle II was more stable and statistically stronger. Thus, it can be said that there is an increase in the strength of implementation effectiveness from Cycle I to Cycle II, which is not only statistically significant but also shows a practically significant increase based on the magnitude of the effect size. The findings show that the Numbered Heads Together (NHT) model has a significant influence on students' mathematics learning outcomes. This finding is shown by the Summary Effect Size value of each consecutive cycle of 0.557 and 0.834, which is in the strong category with a statistical probability of $p=0.01 < 0.05$, respectively. The variance of effects between levels of education was found to be insignificant, indicating that the effectiveness of the implementation of the NHT model was not different at the elementary, junior high, and high school levels. It is indicated by $Q1 = 2.442 < df$ and $Q2 = 1.007 < df$, and each has a value of $p = 1.000 > 0.05$. These findings show that the application of the NHT model can improve mathematics learning outcomes and can be implemented at all school levels. These findings corroborate the findings on the influence of NHT on mathematics learning outcomes at the elementary level by Gracia & Anugraheni (2021) and Fahmawati et al. (2021) at the junior high and high school levels by Rahmandani et al. (2022).

The statistically and practically significant effectiveness of NHT shows that this learning model is not only superior in numerical calculation but also relevant in the context of real learning. This strengthens the research results of Firdaus et al. (2024), which found that NHT encourages an increase in students' mathematical knowledge, responsibility, and confidence, which has implications for improving student learning outcomes. Kridantara et al (2014) and Widiанти et al. (2024) also support this conclusion, stating that NHT improves mathematics learning outcomes.

Forest Plot Analysis

Figure 1 and Figure 2 show the forest plot effect size of Cycle I, the effect size of Cycle II, and the summary effect along with the upper bound and lower

bound. Forest plots provide visual information on research findings (Borenstein et al., 2009).

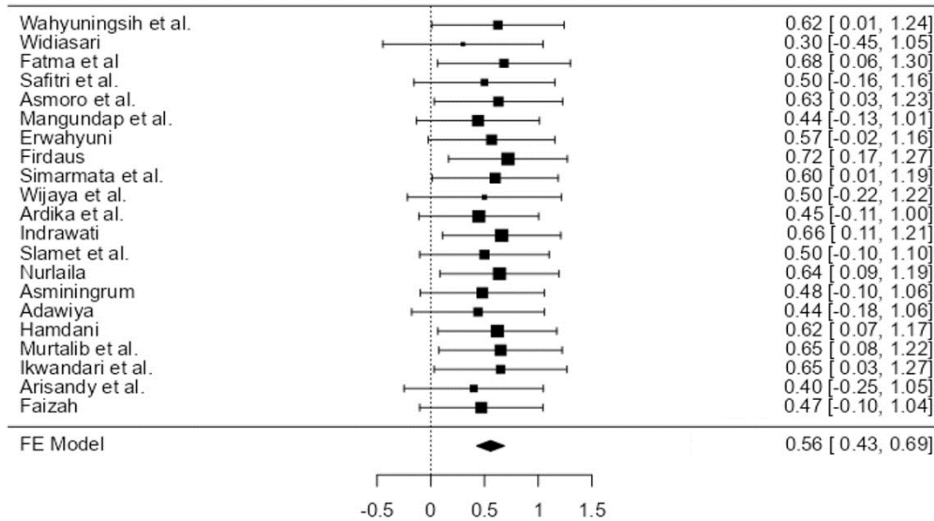


Figure 1. Forest Plot of Cycle I

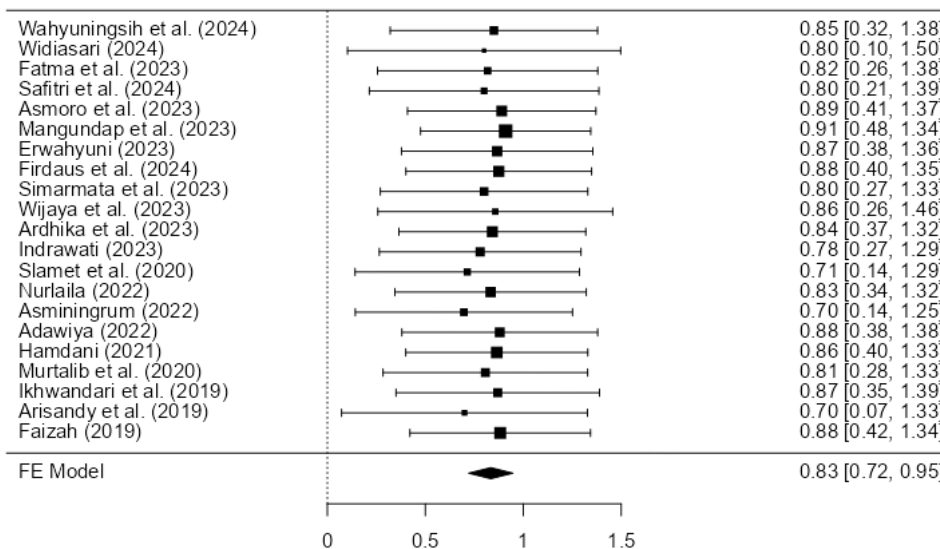


Figure 2. Forest Plot of Cycle II

The forest plots in Figures 1 and 2 show the position of the effect size of the analyzed studies. Based on these two images, it can be seen that the NHT model is effective in increasing the success of mathematics learning because all studies have an effect size of more than 0 (Ridwan et al., 2022). In addition, statistically, all studies contributed to the significance of the summary effect size in each cycle. Although in the first cycle, 11 studies had a lower bound containing zero (Adawiya, 2022; Ardhika & Risnawati, 2023; Arisandy & Sapri, 2019; Asminingrum, 2022; Erwahyuni, 2023; Mangundap et al., 2023; Safitri et al., 2024; Slamet et al., 2020; Widiasari, 2024; Wijaya et al., 2023), the interval in each study was more dominant in the positive area, so it did not have a statistically significant effect. Forest plots show that the summary effect in cycle I is 0.56 with upper-lower bound [0.43; 0.69] and in cycle II of 0.83 with lower-upper bound [0.72; 0.95], which means that in each CAR cycle, the use of the NHT model has a great influence on the achievement of the mathematical MMC.

Publication Bias Evaluation

Publication bias evaluation was carried out to ensure the credibility of the research results in the two implementation cycles. Publication bias can occur when including irrelevant publications (Retnawati et al., 2018). Evaluation of publications in a meta-analysis using Funnel Plot (Figure 3 and Figure 4), Fail-Safe N (FSN), and Egger's Regression methods. The results of the evaluation using these two statistical methods are presented in Table 4.

Table 4. Publication Bias Evaluation

Test Name	Cicle	Value	P
Fail-Safe N	I	512.000	<.001
	II	1568.000	<.001
Egger's Regression	I	-0.750	0.453
	II	-0.674	0.500

Based on the results of the FSN evaluation in Table 4, a very high result was obtained, namely $FSN = 512 > 5(21) + 10$ in Cycle I and increased to $1568 > 5(21) + 10$ in Cycle II, both with a significance value of $p < 0.001$. This high FSN value indicates that the research findings are not susceptible to the influence of publication bias (Ismaniati et al., 2023). The results of the analysis using Egger's Regression Test also showed that there was no significant publication bias either in Cycle I (value = -0.750; $p = 0.453 > 0.05$) or in Cycle II (value = -0.674; $p = 0.500 > 0.05$). The results of Egger's Regression test support the findings of the Fail-Safe N test, which shows that asymmetry in the distribution of effect sizes is not significantly detected, and the results of the study can be considered representative of the analyzed population.

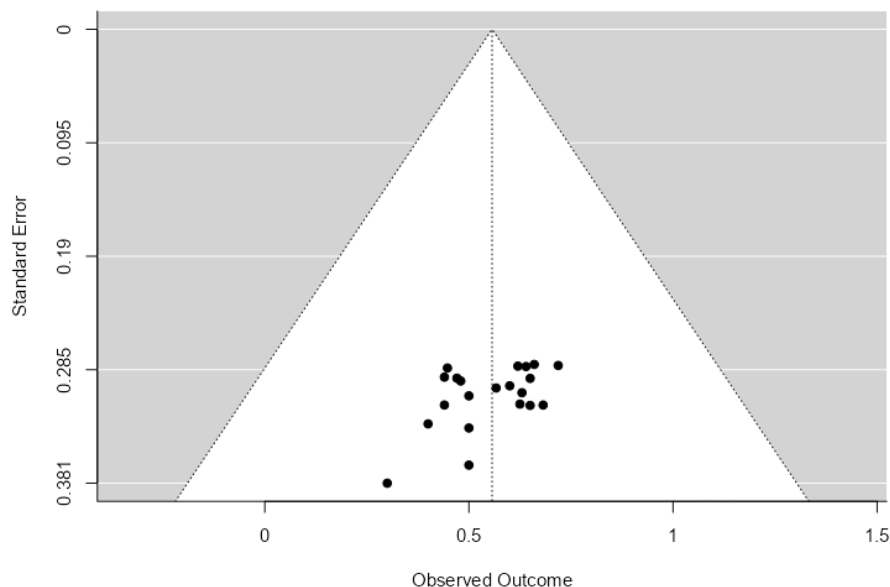


Figure 3. Funnel Plot of Cycle I

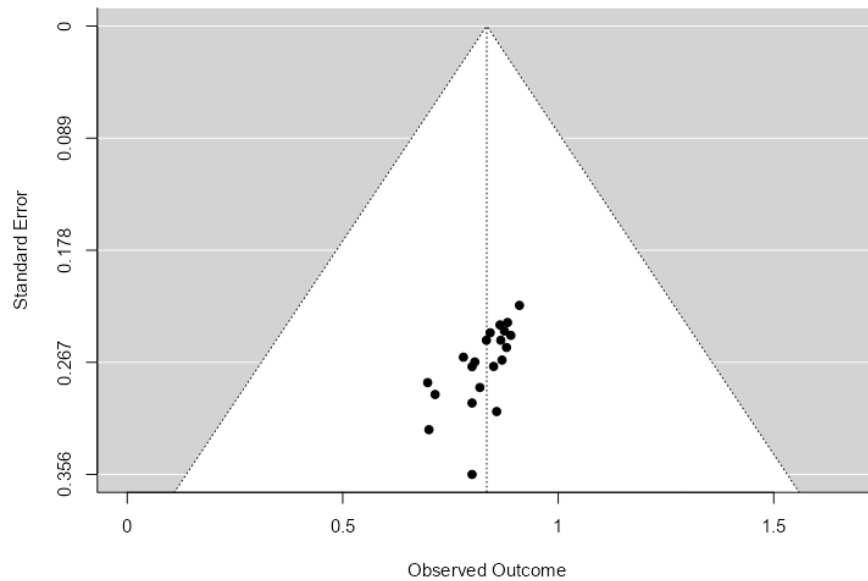


Figure 4. Funnel Plot of Cycle II

Figure 3 and Figure 4 show that all the spheres representing ES and SE are filled (none are empty). In addition, all the black circles are scattered within the area of the white triangle, in cycle I and in cycle II. This means that no publication bias was found in this study. Based on the results of Fail-Safe N and Egger's Test as well as Funnel Plot, there is strong confidence that the findings of this study are not influenced by publication bias (Ridwan et al., 2023). Therefore, the results of the analysis can be used as a basis for drawing scientifically sound conclusions and recommendations.

This meta-analysis research confirms that significant results are not only academically meaningful but can also be applied in the development of learning strategies. The effectiveness of the Numbered Heads Together model can be explained through its three main components, namely numbering, group work, and number calling. The numbering process provides the basis for individual accountability, as each student is aware of the possibility of being called to represent his or her group, thus encouraging active involvement and personal responsibility towards the material studied (Nguyen & Oanh, 2025; Zhou & Colomer, 2024). Group work in NHT fosters intensive social interaction, where students exchange ideas and clarify their understanding, in accordance with the principles of social constructivism that emphasize the importance of collaborative dialogue to build knowledge (Dennick, 2016; Erbil, 2020). Meanwhile, the mechanism of number calling strengthens the principle of positive interdependence, because the success of the group is determined by the readiness of each member, so that a balance is created between individual contributions and collective achievements (Gillies, 2016; Shimizu et al., 2020; Van Ryzin & Roseth, 2022).

Based on the findings of this meta-analysis, mathematics teachers can use NHT as one of the alternative learning strategies that encourage active student engagement and strengthen academic achievement in the classroom. For further research, it is recommended to expand the scope of learning outcome indicators

used in primary studies, not limited to MMC. Future meta-analyses can incorporate data from more comprehensive assessment results, both cognitive and non-cognitive aspects, so that the conclusions obtained are more holistic and can be generalized more broadly.

CONCLUSION

Based on the results of the analysis and discussion, it was concluded that the Numbered Heads Together (NHT) model had a significant influence on the success of mathematics learning at all levels of education. This meta-analysis involved 21 primary studies from the elementary school, junior high school, to high school levels. The estimated results showed that the summary effect size in the first cycle was 0.557 and increased to 0.834 in the second cycle, both of which were in the strong and statistically significant category ($p < 0.001$). The heterogeneity test showed $I^2 = 0\%$ and the Q value was insignificant ($p = 1,000$), which means that the data are homogeneous and support the use of a fixed-effect model. The results of the publication bias test using the Fail-Safe N method (512 in cycle I and 1568 in cycle II) and Egger's Regression ($p > 0.05$) also indicated the absence of publication bias, so that the results of this meta-analysis were credible and objective.

An important contribution of this meta-analysis is to provide a robust generalization regarding the effectiveness of the NHT model, complementing the previously partial and statistically incomprehensible class action research. These findings enrich the mathematics learning literature with more solid quantitative evidence, while confirming that the application of NHT can be widely recommended at all levels of education. At the practical level, teachers can make NHT an effective learning strategy to improve the achievement of mathematics MMC, while for future researchers, this result opens up space to explore the application of NHT in a variety of learning contexts.

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