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Meta Analysis: The Effect of STAD Type Cooperative Learning Model on Students' Mathematics Learning Outcomes

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ABSTRACT

Several studies have shown that the STAD cooperative learning model has an effect on improving students' mathematics learning outcomes. However, the results of these studies still vary. Therefore, it is necessary to conduct a meta-analysis to find out comprehensively. The purpose of this study was to determine the effect of the STAD type cooperative learning model on students' mathematics learning outcomes, in addition, this study also aimed to see the differences in the effect of the STAD type cooperative learning model in the education level. This study used the meta-analysis method. The method is a synthesis of quantitative research that uses numbers and statistics from various research results to measure and separate information from the resulting data so as to improve completeness. This meta-analysis was conducted using the PRISMA protocol. The results stated that the STAD type cooperative learning model had an effect on student learning outcomes with an overall effect size of 1.38 so that it could be said to be in the very large effect category. Meanwhile, when viewed from the level of education, the largest average effect size is the high school level but there is no significant difference in influence. Based on the results of this study, the STAD type cooperative learning model can be used as a recommendation as a learning model that can be applied at all levels of elementary, junior high and high school.

Keywords: Cooperative, STAD, Math Learning Outcomes, and Meta Analysis

INTRODUCTION

Education is a conscious and planned effort to create a learning atmosphere and learning process so that students are able to actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble character and skills needed by themselves, society, nation and State (Abd Rahman BP, 2022) . As the foundation of education, it is only natural that educational institutions are supervised and improved in order to prepare competent young people. Teachers are implementers and managers of education who are expected to improve the quality of education along with advances in science and technology. Teachers play an important role in determining the success of the teaching and learning process carried out by students. In addition, teachers help learners to develop their potential as human beings.

Learners obtain various kinds of lessons in the learning process to gain knowledge and other knowledge that is useful for themselves and those around them (Hamdani and Rohayati, 2017) . Mathematics is one of the

subjects that students learn. Mathematical concepts play an important role in students' daily lives.

Mathematics is a discipline that has a significant impact on the development of science and technology. This helps both in its application to other scientific fields and in the development of mathematics itself (Rahmadan, Sessu and Faradillah, 2020) . Mathematics learning subjects are given to students with the aim of developing logical, analytical, systematic, critical, and creative thinking skills, as well as the ability to work together. Therefore, it is important for teachers to know the learning materials and how to communicate them in order to teach math lessons effectively. In this context, the methods and ways of teaching used by teachers should foster enthusiasm for learning and the willingness of learners to get more information.

In learning mathematics, many problems are found, one of the problems that often occurs is the low mathematics learning outcomes of students in Indonesia, as reflected in the 2022 *Program for International Student Assessment* (PISA) results, with a score of 366, down 13 points compared to 2018 (Schleicher, 2023) .

Low student learning outcomes can be caused by various factors, one of which is the teaching method used by teachers who fail to make students interested in the learning process (Maduratna and Setyawan, 2020) . Teachers who fail to attract students' attention and provide ineffective material explanations can cause boredom, disinterest, and confusion among students during learning, leading to passive learning

One of the learning models that can be used to improve student success is the cooperative learning model in line with Laia, (2024) which suggests that cooperative learning is an alternative learning model that can be used to approach problems, be able to work on large tasks, improve communication and social skills and self-confidence and according to Riyanto in Sukasih (2018) suggests that cooperative learning is a learning model designed to learn academic skills, as well as social skills. Cooperative learning is one of the innovative learning models that can provide active learning conditions for students, so that students can more easily understand the lesson (Irwanti and Widodo, 2018) .

One of the cooperative learning models is the STAD type. Student Team Achievement Divisions (STAD) is one of the simplest learning types and is a good approach for teachers who are just starting to implement cooperative learning models in the classroom (Laa, Winata and Meilani, 2017) . In the STAD type cooperative learning model, students are placed in heterogeneous small groups of four to six members according to the ability of students with the aim of peer guidance, to control and facilities from the teacher for things that are not yet understood, and to be responsible for the results of group assignments to be presented (Noviana and Huda, 2018) .

The discussion of the STAD type cooperative learning model on mathematics learning outcomes can be accessed easily along with the development of science and technology. Research results that have been conducted by others are then conveyed by reference sources such as electronic journals and repositories. Data in digital form can be accessed through the internet network to meet information needs in enriching primary literature.

Meta analysis is a method by combining several research results of several studies to get stronger results and conclusions (Kurniawati *et al.*, 2023) . Use for research purposes can use libraries, books and journals as data sources. Some research on the STAD learning model reveals that the use of the Student team Achievement Division (STAD) type cooperative learning model has a positive effect on student learning outcomes (Nurani, Afghohani and Exacta, 2020) .In addition, in Farda and Amaliyah (2023) research shows that the application of the STAD type cooperative learning model is proven to have a significant effect on student learning outcomes and makes students more active and enthusiastic in learning activities,

Walijah (2017) suggests that there is an effect of the application of the STAD type cooperative model on math learning outcomes with the results of the effect size test of 0.8.

The number of studies on the effect of STAD type cooperative learning model on mathematics learning outcomes including by Rohmani (2022); Islami, Soeprianto and Prayitno (2021); Nurani, Afghohani and Exacta (2020) and there are many more studies that examine the effect of STAD type cooperative learning model on student learning outcomes, especially mathematics. Based on the number of similar previous studies, it is necessary to conduct a meta-analysis to comprehensively determine the effect of the STAD type cooperative learning model on Mathematics learning outcomes.

Based on this description, the purpose of this study was to determine the effect of the STAD type cooperative learning model on students' mathematics learning outcomes. It is hoped that this research can provide an overview and alternatives in improving students' mathematics learning outcomes through the STAD type cooperative learning model. In addition, this study also aims to determine the difference in the effect of the STAD type cooperative learning model at the education level.

MATERIALS & METHODS

This research uses the meta-analysis method. The method is a synthesis of quantitative research that uses numbers and statistics from various research results to measure and separate information from the resulting data so as to improve completeness. Furthermore, meta-analysis is a form of research by systematically re-processing secondary data through quantitative methods so as to obtain accurate conclusions. This meta-analysis was conducted using the PRISMA protocol. According to Moher in Agus Jayadi (2021) PRISMA is a method used to conduct literature review and meta-analysis activities so that it makes it easier to review the road map structure of research objectives.

The meta-analysis steps were carried out through several stages, namely: 1) defining the research problem, 2) collecting data, 3) coding all primary studies that have been determined, 4) conducting statistical analysis with the calculation of effect size and effect error, heterogeneity test and estimation model, publication bias test and moderator variable test 5) presentation of research results (Retnawati *et al.* ., 2018)

In the first step of defining the research problem, the researcher defines a specific research problem in this case is the effect of the STAD type cooperative learning model on math learning outcomes with keywords that will be used to search and retrieve articles and theses, namely "STAD method" and "learning outcomes".

In the second step of collecting data, researchers use the Prism SOP, in which there are stages carried out, namely the search for research articles by collecting data from various primary studies, be it articles, theses and so on that are relevant. Researchers will search for studies that examine the effect of the STAD type cooperative learning model on student math learning outcomes with the keywords "STAD model" and "learning outcomes" which will be used in the search. After the studies are searched, filtering and sorting will be carried out. At the sorting stage, articles and theses are then deleted due to duplication. Furthermore, the selection of articles and theses is specifically done by filtering articles and theses based on inclusion criteria. The table below is the inclusion criteria

Table 1. Inclusion Criteria

No.	Inclusion
1.	National scientific articles and theses related to the stad model and learning outcomes
2.	Articles and Thesis published in the last 5 years
3.	Relates to math disciplines
4.	Relates to elementary, middle and high school levels

5.	Using quantitative research with experiments
6.	There is a comparison class
7.	Complete data (number, mean, and standard deviation) of control class and experimental class

To make it easier by using a prism soup as shown below

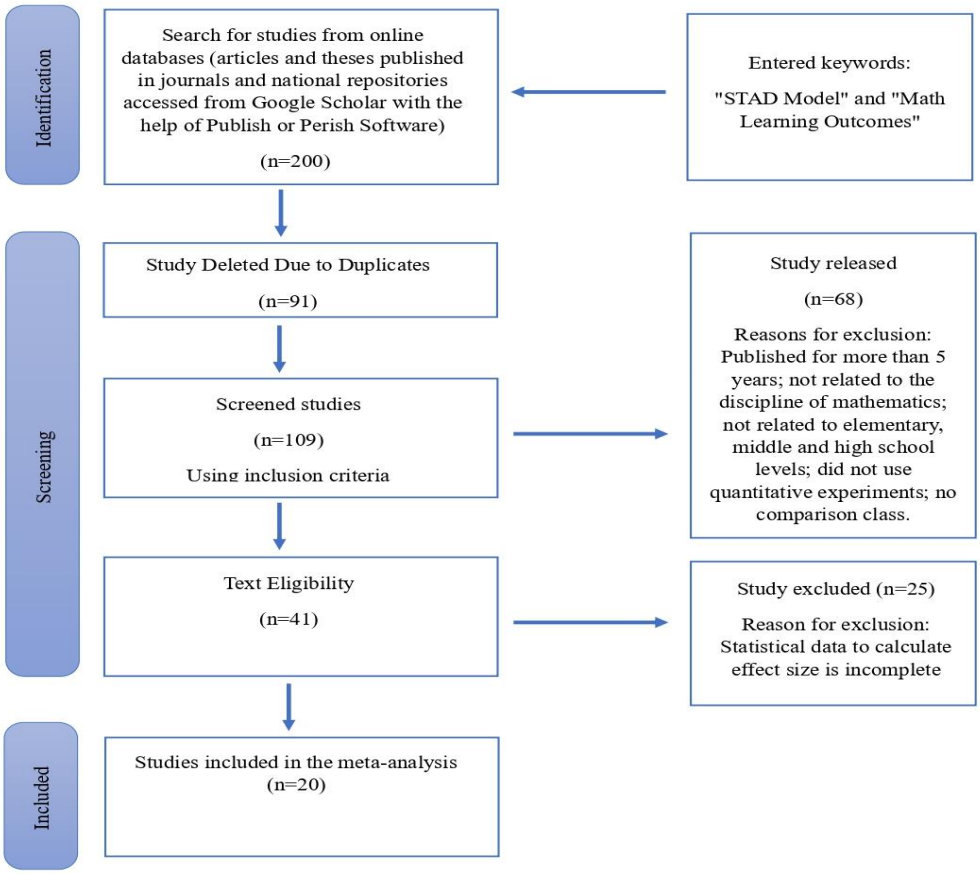

Figure 1. PRISMA SOP

After the primary data is filtered, the third step will be carried out, namely coding all the studies that have been determined, where in this step the researcher codes the data from each selected study, the coded information will cover the information obtained in the articles and theses. Furthermore, it will be continued with the fourth step, namely conducting statistical analysis by calculating the effect size and standard error, heterogeneity test and estimation model, hypothesis testing and the most recent publication bias test. All statistical calculation processes are assisted using excel and jasp.

STATISTICAL ANALYSIS

The first statistical analysis carried out is the calculation of effect size and standard error where the calculation of the effect size and standard error obtained will be included in jasp to help get the results of other tests. In the calculation of effect size according to Retnawati *et al* (2018) begins with an evaluation of the standardized mean difference(d) where the study involves two groups (treatment & control) with different measurement scales, using the following formula:

$$\mathrm{d} = \frac{\bar{X}_E - \bar{X}_C}{S_{within}} \text{ with} S_{within} = \sqrt{\frac{(n_1-1)S_1^2+(n_2-1)S_2^2}{n_1+n_2-2}}$$

The variance of d is obtained from$V_d =$

$\frac{n_1+n_2}{n_1 n_2} + \frac{d^2}{2(n_1+n_2)}$ then the standard error of d is the square root of the variance with the formula$SE_d = \sqrt{V_d}$. Hedges modifies d to reduce bias (overestimation). formulated as $g = J \times d$, whereJ is the correlation factor. The correction factor(J) is formulated as$J = 1 - \frac{3}{4df-1}$, where df is the degree of freedom$(n_1 + n_2 - 2)$. variance g with the formula$V_g = J^2 \times V_d$ with standard error$SE_g = \sqrt{V_g}$. Then Effect size is classified according to Cohen in Tamur *et al* (2021) namely, less or equal to 0.2 is a small effect, between 0.21 to 0.50 is a medium effect, between 0.51 to 1.00 is a large effect, and more than 1.00 is a very large effect.

After the effect size is determined for each study, the next step is to conduct a heterogeneity test to check that the primary studies used are heterogeneous if the value of$p < 0$,5 which means that there are differences in effect size so that the estimation model used is a random effect model. Next, the Foresplot data that has been obtained will be interpreted according to its classification.

The next step will be the publication bias test to detect the presence or absence of publication bias, seen from the funnel plot in JASP, if the funnel plot is symmetrically distributed on the vertical line representing the combined effect size, then the study is considered resistant or free from publication bias, but if the funnel plot shows results that are less symmetrical or difficult to see the symmetry, the fail safe N (FSN) test is used to see the impact of bias that exists if the value$\frac{N}{(5k+10)} > 1$ *where k is the number of primary studies and N is the FSN value*. Furthermore, hypothesis testing is carried out by testing the p-value of the z statistic, the H0 rejection criterion is$p - value < 0{,}05$ which means there is an influence. The next test analyzes the moderator variable by checking the value of $p - value < 0{,}05$

RESULT

From the entire set of PRISMA standard operating procedures (SOP), there are 16 primary studies that can be analyzed. The information from the 16 studies will be presented in the following table.

Table 2. List of Articles and Thesis

Code	Year	Author Name	Title	Journal/Scholarship
A.1.1	2022	Zuliana Rohmani	The Effect of STAD Learning Model on Mathematics Learning Outcomes of Grade V SDN 3 Pancor	Journal
A.1.2	2021	Ayu Siti Rahmawati, Syafri Ahmad	The Effect of Student Team Achievement Division Cooperative Model on Learning Outcomes of Perimeter and Area of Flat Buildings in Class IV Elementary School	Journal
A.1.3	2022	Ayunissa Cahyaningrum, Arief Cahyo Utomo	The Effect of Student Team Achievement Division (STAD) Learning Model and Congklak Media on Mathematics Learning Outcomes	Journal
A.1.4	2022	Rahmi	The Effect of the Application of Student Teams Achiemnt Division (STAD) Cooperative Learning Model on Mathematics Learning Outcomes of High Grade Students of SD Negeri 233 Ussu, East Luwu Regency	Journal
A.2.1	2021	Vina Hidayat Islami, Harry Soeprianto, Sudi Prayitno	The effect of student teams achievement division type cooperative learning model on math learning outcomes	Journal
A.2.2	2023	Harry Henry Masrikat, Sylvia J.A. Sumarauw, Ontang Manurung, Navel Oktaviandy Mangelap	The Effect of Stad Type Cooperative Learning on Mathematics Learning Outcomes of Class VIII Students of SMPN 4 Selaru	Journal

A.2.3	2023	Afrindah Wulandari, Lily Rohanita Hasibuan	The Effect of STAD Learning Model with Geogebra Media Assistance on Mathematics Learning Outcomes of Junior High School Students	Journal
A.2.4	2021	Nurhasanah	The Effect of STAD Type Cooperative Learning Model on Students' Motivation and Mathematics Learning Outcomes on the Subject of Straight Line Equations in Class VIII MTs. Muhammadiyah 22 Padangsidimpuan	Thesis
A.2.5	2022	Moch. Shalehhudin, Zainul Munawwir, Lisma Dian Kartika Sari	The Effect of Student Teams Achievement Division (STAD) Cooperative Learning Model Assisted by Recreational Math and Pupytha Props on Student Learning Outcomes	Journal
A.2.6	2022	Hermanto, Nanda Aprilia, Yusryanto	The Effect of Cooperative Learning Model Type STAD (Student Team Achievement Divisiont) on Mathematics Learning Outcomes of Set Material for Class VII Students at SMPN 1 Unaaha	Journal
A.2.7	2020	Khoirul Anam, Nor Rohman, Anita Dewi Utami	The Effect of Student Team Achievement Divisions (STAD) Cooperative Learning Model on Math Learning Achievement	Journal
A.2.8	2020	Imam Solahudin	The Effect of Cooperative Learning Model Type Student Team Achievement Division (STAD) on Mathematics Learning Achievement	Journal
A.2.9	2023	Putri Mayang Sari, Edwin Musdi	The Effect of STAD Type Cooperative Learning Model on Mathematics Learning Outcomes of Class VIII Junior High School Students	Journal
A.3.1	2023	Wembli Pebakirang	The Effect of Stad Type Cooperative Learning Model on Student Learning Outcomes on Two-Variable Linear Inequality System Material at SMA N 1 Tabukan Selatan	Journal
A.3.2	2024	Yollanda Yorend, Elita Zusti Jamaan	The Effect of Stad Type Cooperative Learning Model on Mathematics Learning Outcomes of XII MIPA Class Students of SMAN 8 Padang	Journal
A.3.3	2024	Siska Endah Nuraeni, Afif Afghohani, Anita Dewi Utami	The Effect of STAD Type Cooperative Learning Model on Mathematics Learning Achievement of High School Students	Journal

Primary data from all these studies will be extracted. Then presented in the table below

Table 3. Primary data extraction results

Code	Experiment Class			Control Class		
	N	Mean	SD	N	Mean	SD
A.1.1	30	78,5	10,26796	30	62,1667	10,56044
A.1.2	15	87,46	13,1	15	66,6	13,95
A.1.3	28	90,36	11,049	28	79,64	12,317
A.1.4	22	85,73	8,8	22	73,68	10,348
A.2.1	41	70,32	15,82	42	64,1	13,69
A.2.2	15	75,93	15,56308	15	63,2	15,8844
A.2.3	31	85,94	3,949	32	73,78	3,348
A.2.4	25	79,7	11,54	22	71,03	13,94
A.2.5	27	86	6,07	27	71,3	8,08
A.2.6	19	61,404	17,268	21	31,373	17,261
A.2.7	32	73,4375	7,8738	32	69,5313	6,8814
A.2.8	37	21,49	2,512	37	17,08	2,326

A.2.9	32	65	23,68	32	47,75	21,38
A.3.1	30	90,6	4,538	30	67,833	5,855
A.3.2	34	70	24,92	34	54	24,56
A.3.3	36	81,6667	8,678	36	77,3333	9,02

In the table above, information on data extraction from the primary study is presented, which is divided into 3 groups based on education level, namely primary school level group with code A.1, junior high school with code A.2 and senior high school with code A.3, which will be used for the calculation of effect size and standard error with the help of Ms. Excel software.

All data that has been extracted is calculated using Ms. Excel Software to get the effect size and standard error, the results of the calculation of effect size and standard error are presented below.

Table 4. Effect Size and Standard Error Calculation Results

Code	ES	SE
A.1.1	1,547847	0,293307
A.1.2	1,499904	0,410203
A.1.3	0,903440	0,278967
A.1.4	1,231988	0,326863
A.2.1	0,416923	0,220928
A.2.2	0,787682	0,374643
A.2.3	3,285030	0,386576
A.2.4	0,670365	0,298135
A.2.5	2,027275	0,334087
A.2.6	1,704925	0,367872
A.2.7	0,521858	0,252774
A.2.8	1,802679	0,275096
A.2.9	0,755363	0,257397
A.3.1	4,290012	0,470305
A.3.2	0,639332	0,247372
A.3.3	0,484349	0,237918

The results of the calculation of effect size and standard error in the table above are then inputted into the JASP software to get other test results.

Furthermore, the results of the input to JASP will be tested for heterogeneity and determine the estimate to get the overall effect size as shown below.

Table 5. Heterogeneity Test

Fixed and Random Effects			
	Q	**df**	**p**
Omnibus test of Model Coefficients	28.936	1	< .001
Test of Residual Heterogeneity	128.274	15	< .001
Note. p -values are approximate.			
Notes. The model was estimated using the Restricted ML method.			

Based on the table above, it is known that the p value is <0.001 with a 95% significance level =0.05. Therefore, the p value <0.05, thus indicating that there are differences in effect size in each study (Heterogeneous). This indicates that the appropriate model to determine the combined effect size of all studies is the random effect model.

In the next stage, the visualization of the results of the meta-analysis carried out consists of the results of the effect size and the confidence interval of each primary data and the results of the summary effect.

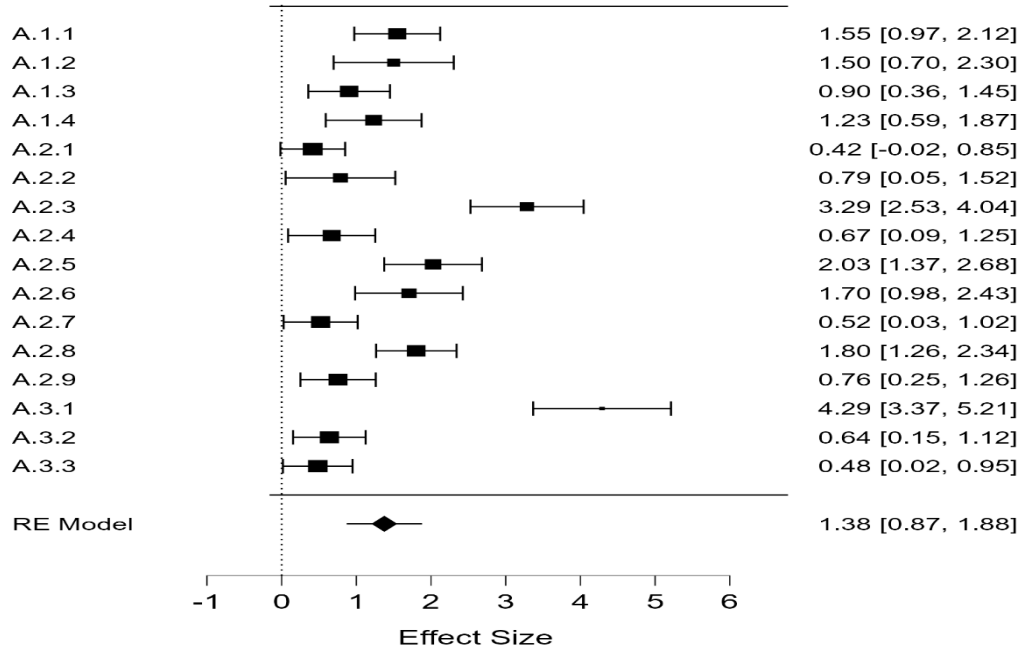

Figure 2. Forest plot

The figure above shows that the effect size of each study is in a varied classification. There are 8 studies with a very large effect size, 6 studies with a large effect size, and 2 studies with a medium effect size.

Next, a publicity bias test is conducted to detect whether there is bias or resistance to bias.

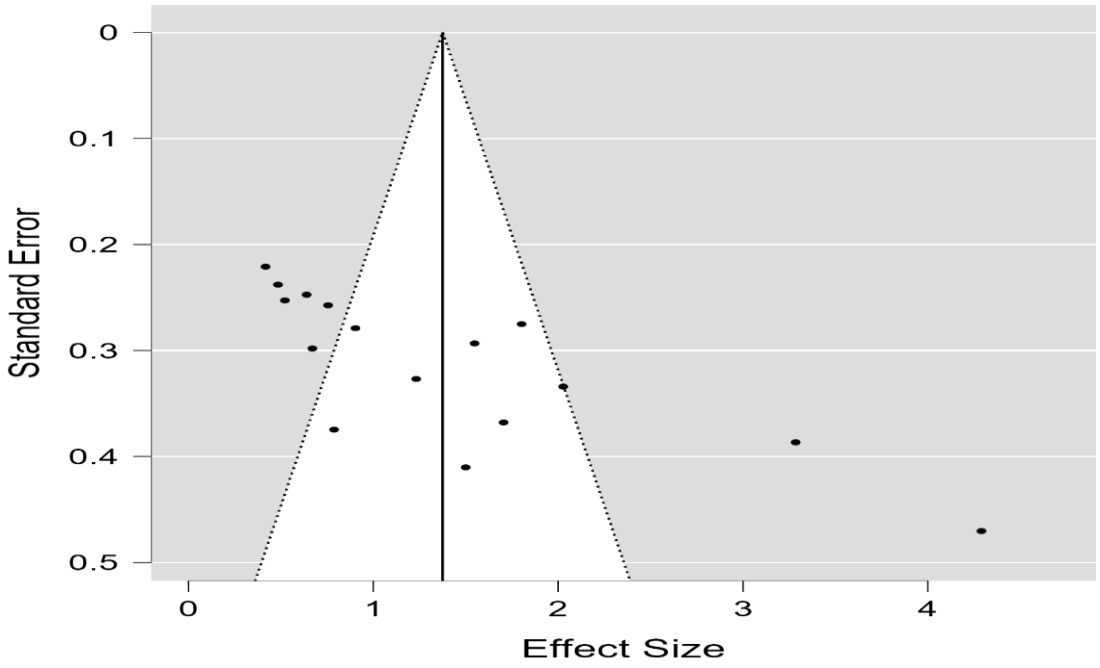

Figure 3. Funnel plot

Since it is difficult to describe that the shape of the funnel plot above is symmetrical, we will conduct the fail-safe N(FSN) test according to the data table below.

Table 6. Fail Safe Test N

File Drawer Analysis			
	Fail-safe N	**Target Significance**	**Observed Significance**
Rosenthal	1628.000	0.050	< .001

With the formula $\frac{1628}{5 \cdot 15+10}$, the result 19.152>1 is obtained so that it can be said that the 16 primary data are resistant to publication bias and are suitable for use in further analysis.

Next, hypothesis testing was conducted using a random effects model, as shown in the table below.

Table 7. Hypothesis Test

Coefficients				
	Estimate	**Standard Error**	**z**	**p**
intercept	1.375	0.256	5.379	< .001
Notes. Wald test.				

It can be seen in the table above that the p-value of the z test statistic is <0.001, so based on the criteria for rejecting H0 if $p-value < 0,05$ is met. This indicates that the application of the STAD learning model to student math learning outcomes has a significant effect.

After the hypothesis test shows a significant effect on the whole study. The next step is to analyze moderator variables based on education level, as shown in the table below.

Table 8. Moderator Variable Analysis

No.	Education Level	n	g	Q	Qw	Qb	df	p-value
1.	SD	4	1,26	2,946	126,9220	1,352	2	0,509
2.	SMP	9	1,31	68,217				
3.	HIGH SCHOOL	3	1,78	55,759				

The results of the analysis of moderator variables given in the table above, the effect size in studies conducted in elementary schools (SD) 1.23 in the very large category is not much different from the effect size in studies conducted in junior high schools (SMP) 1.31 in the very large category, while the effect size in studies conducted in senior high schools (SMA) 1.78 in the very large category. The Qb value was 1.351 and $p-value > 0,05$ with the $p-value$ value being $0,509$. This shows that the average effect size between education levels has no significant difference, which indicates that the application of the STAD type cooperative learning model is very effective and influential at all levels, both elementary, junior high and high school.

DISCUSSION

Of the 200 articles and theses obtained from Google Scholar, 16 articles and theses passed the inclusion criteria and met the Prisma SOP.

The results of this study show that the average effect size of the entire study is 1.38 which indicates that there is a very large influence through STAD type cooperative learning. This is in line with the research of Islami et al (2021) which suggests that there is a significant increase between the mathematics learning outcomes of the experimental class and the control class. Rahmawati & Ahmad (2021) concluded that there was a positive and significant effect on the use of the STAD type cooperative model on integrated thematic learning outcomes.

Based on education level, elementary, junior high and senior high school fall into the very large size category. The highest effect size

was found at the high school level followed by junior high school, and then elementary school. This is in line with Piaget's theory which explains that high school students are in the formal operational stage, have the ability to think logically and abstractly (Marinda, 2020) . However, there is no significant difference in the average effect size between educational levels, which indicates that the application of the STAD type cooperative learning model is effective and influential in elementary, junior high and high school.

CONCLUSION

Based on 16 articles and theses, overall, the average effect size is 1.38, including in the large effect category. This means that the STAD type cooperative learning model has a significant effect with a large effect in the learning process. So that the STAD type cooperative learning model can be used as an alternative learning model that is effective for improving students' Mathematics learning outcomes.

Meanwhile, based on the level of education, both elementary, junior high and high school have a very large influence, but there is no significant difference in the average effect size between education levels. This shows that the STAD type cooperative learning model is effective and influential at the elementary, junior high and high school levels.

Declaration by Authors

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