META ANALYSIS: THE EFFECT OF COOPERATIVE LEARNING MODELS ON STUDENTS' CRITICAL THINKING ABILITIES

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Abstrak

Keterampilan berpikir kritis merupakan salah satu kompetensi penting yang harus dimiliki oleh siswa dalam menghadapi tantangan abad ke-21. Kemampuan ini mencakup kemampuan untuk menganalisis, mengevaluasi, dan menyintesis informasi secara efektif, yang sangat penting dalam pengambilan keputusan yang tepat dan pemecahan masalah yang kompleks. Model pembelajaran kooperatif memiliki potensi besar dalam meningkatkan keterampilan ini dengan melibatkan siswa dalam kerja kelompok yang mendorong interaksi, diskusi, dan berbagi ide. Banyaknya penelitian terkait penerapan model pembelajaran kooperatif dalam meningkatkan kemampuan berpikir kritis peserta didik sehingga dilakukan penelitian meta analisis untuk menggabungkan hasil penelitian tersebut menjadi satu kesimpulan. Penelitian ini dilakukan untuk mengetahui pengaruh model pembelajaran kooperatif terhadap kemampuan berpikir kritis peserta didik. Penelitian ini menggunakan pendekatan kuantitatif dengan jenis penelitian meta analisis. Pengumpulan data dilakukan dengan mencari laporan penelitian yang sesuai dengan topik yang dikaji pada situs jaringan internet. Teknik pengambilan sampel menggunakan teknik purposive sampling. Instrumen yang digunakan adalah lembar pengumpulan data. Analisis data dilakukan dengan menggunakan statistik deskriptif dan statistik inferensial. Berdasarkan penelitian yang dilakukan disimpulkan bahwa model pembelajaran kooperatif berpengaruh terhadap kemampuan berpikir kritis peserta didik. Sehingga, model pembelajaran kooperatif efektif digunakan dibanding model konvensional dalam meningkatkan kemampuan berpikir kritis peserta didik.

Kata Kunci: Berpikir Kritis; Meta Analisis; Model Pembelajaran Kooperatif

Abstract

Critical thinking skills are one of the important competencies that students must have in facing the challenges of the 21st century. These skills include the ability to effectively analyze, evaluate and synthesize information, which is crucial in making informed decisions and solving complex problems. Cooperative learning models have great potential in improving these skills by engaging students in group work that encourages interaction, discussion and sharing of ideas. There are many studies related to the application of cooperative learning models in improving students' critical thinking skills so that meta-analysis research is conducted to combine the results of these studies into one conclusion. This research was conducted to determine the effect of

cooperative learning models on students' critical thinking skills. This research used a quantitative approach with the type of meta-analysis research. Data collection was carried out by searching for research reports in accordance with the topics studied on internet network sites. The sampling technique used purposive sampling technique. The instrument used was a data collection sheet. Data analysis was carried out using descriptive statistics and inferential statistics. Based on the research conducted, it is concluded that the cooperative learning model affects the critical thinking skills of students. Thus, cooperative learning models are effective compared to conventional models in improving students' critical thinking skills.

Keywords: Cooperative Learning; Critical thinking; Meta Analysis

INTRODUCTION

Education plays an important role in shaping individual personalities and is one key to improving human resources in a nation (Lubis, 2019), thus creating an education that can become a home in developing students' knowledge and skills is the most important thing that needs attention. The National Educational Technology Standards for Students (NETS-S) outlines 6 skills that students must master and that teachers at schools must develop and train, one of which is critical thinking skills (Syahputra, 2018). Critical thinking is one of the skills that needs to be trained in students because it is a major goal in education (Solihah, 2019).

Critical thinking is a higher level thinking process so it requires more complex thinking skills. Critical thinking requires students to organize, interpret, analyze, evaluate, conclude, and explain information in a coherent manner. Students who are able to think critically can determine which information is important, irrelevant, or useless (Kaliky & Juhaevah, 2018; Risa et. al., 2023; Suparman et. al., 2023). Students' critical thinking abilities are not an innate ability inherent in students but are honed in the learning process, one of which is in the field of mathematics (Fayakuun & Agoestanto, 2023).

The habit of critical thinking in the curriculum, especially mathematics subjects, can prepare students to face a wider life. Encouraging critical thinking in

mathematics learning is the same as investing in the future, adapting, innovating and developing according to increasingly complex and interconnected times (Pratiwi et. al., 2023). The Trends International Mathematics and Science Study (TIMSS) survey and the International Program for Student Assessment (PISA) stated that Indonesian students' mathematical critical thinking skills are still low, so improvements are needed in all aspects of mathematics learning. One of the most influential things in the learning process is the learning model used (Tamsar, 2018).

Several previous studies used cooperative learning models to overcome this problem. The cooperative learning model involves a number of students with different abilities in one small group. The stages of cooperative learning are: preparation stage, scaffolding stage, and evaluation and award stage . Discussion activities in groups can encourage students' critical thinking skills, starting with students analyzing problems, asking friends, conveying ideas to solve problems, then drawing conclusions (Rizki et. al., 2023)

Various studies related to the influence of the cooperative learning model on students' critical thinking abilities, including research conducted by Hardianti (2018) found a conclusion that TAI type cooperative learning has a positive influence on the critical thinking abilities of class X students. As for research by Rahmawati, Hamid, dan Izzatin (2019) shows that the average score of students taught using the TAPPS cooperative learning model is higher than the conventional learning model. Tamsar (2018) shows that the critical thinking abilities of students who receive Team Assisted Individualization (TAI) cooperative learning model learning are higher than students who receive expository model learning. There is a large amount of research data related to the application of various types of cooperative learning models in improving students' critical thinking skills, so to provide overall research conclusions and be able to summarize all previous research, new research with the type of meta-analysis research is needed. Meta analysis is a type of research that synthesizes previous research that is mutually

relevant so that the data is secondary data (Retnawati, Apino, Kartianom, Djidu, & Anazifa, 2018).

In the field of education, a lot of meta-analysis research has been carried out. As research by Sukmawati (2020) concluded that the average effect of implementing the PBL model on critical thinking skills was 1.21 and was in the large effect category. Likewise, Amin (2020) obtained an average effect size in the medium category, namely 0.73, meaning that cooperative learning can improve students' learning achievement. Putra (2020) shows that the Jigsaw learning model is more effective when compared to the Numbered Head Together learning model, there is an increase in students' critical thinking abilities.

Of the various meta-analysis studies that have been presented, there has been no meta-analysis research with a theme that addresses the influence of the cooperative learning model on students' overall critical thinking abilities, especially in the field of mathematics. Therefore, researchers have an interest in conducting meta-analysis research from various studies that have been carried out by previous mathematics education practitioners related to the influence of cooperative learning models on students' critical thinking abilities. The aim of this research was to the influence of the cooperative learning model on students' critical thinking abilities.

METHOD

This study uses a quantitative approach. The quantitative approach, the direction and focus of the research, is to build theory from existing data or facts and quantitatively requires a lot of use of numbers. This type of research is meta-analysis research with a pre-post contrasts meta-analysis design. Meta Analysis is research using previous studies (secondary data) which is carried out systematically and quantitatively to obtain accurate conclusions (Retnawati, Apino, Kartianom, Djidu, & Anazifa, 2018).

The population in this study are reports of previous research results in the form of theses, theses, dissertations, national journals and international journals that

have been published nationally and internationally in the period 2012-2022, which relate to the influence of the cooperative learning model on students' critical thinking abilities. The sample is from the population that meets the sample criteria. The sampling technique is purposive sampling technique . The sample criteria set are:

1. Researchers in research results reports are general researchers or students.
2. The research was conducted in the 2012-2022 time frame.
3. The research subject is related to the influence of the cooperative learning model on students' critical thinking abilities.
4. For research results reports in the form of national journals published in journals accredited at least Sinta-4, refer to journal accreditation data by the Ministry of Research, Technology and Higher Education of the Republic of Indonesia (Kemeristekdikti) in https://sinta.kemdikbud.go.id/
5. For research results reports in the form of international journals indexed in well-known international databases (Web of Science, Scopus, Index Copernicus International, and Microsoft Academic Search) or journals indexed in DOAJ.
6. The research was conducted at the junior high school (SMP) and senior high school (SMA) levels.
7. The research was conducted in Indonesia.
8. The type of research used is experimental research which only involves two groups, namely the experimental group and the control group
9. The control class uses a conventional learning model.
10. Data used to calculate the complete effect size value in the research results report.

Researchers search for research reports related to research topics through databases such as (Google Scholar , Repository, Scopus , DOAJ, onesearch , IPI, ICI, Crossref, pdfDrive). Searches were also carried out specifically on several mathematics education research journal sites. The keywords used are "the influence

of cooperative learning models" and "critical thinking skills". The research report that was obtained was then analyzed to determine the sample using a flow diagram from PRISMA with sample criteria from a predetermined population. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta Analyses) are reporting guidelines designed to produce transparent, complete, and accurate reporting of systematic reviews and meta analyzes (Page, JE, PM, Boutron, Hoffman, & Mulrow, 2020). PRISMA are guidelines designed to assist researchers in reporting systematic reviews and meta-analyses in a transparent and complete manner. The guidelines include checklists and flow diagrams that guide researchers through the process of selecting, screening and presenting study results.
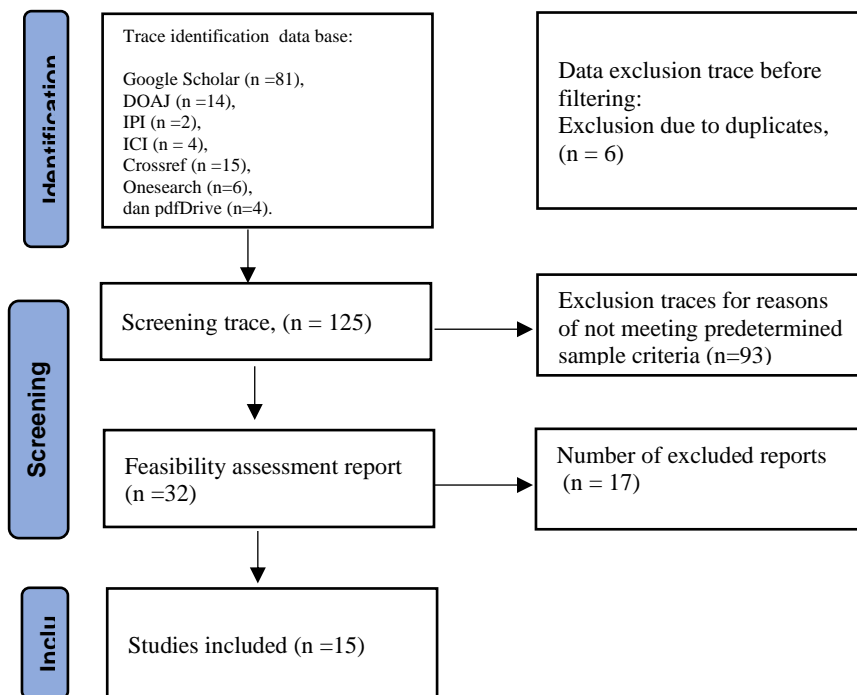
Gambar 1. *Prisma Flow Diagram*

The instruments used in this research are coding sheets and information on each research report in digital form, namely in Microsoft Excel. This sheet consists

of two types, namely a data collection sheet for non-sample research results reports and a data analysis sheet for research results reports.

The research results were then processed using descriptive statistical techniques to determine the effect size and summary effect (average effect size) as well as inferential statistics to test the hypothesis. Effect size is the difference in the incidence of effects between the experimental group and the control group in meta-analysis, which is the combined effect size of each study.

Effect size can be calculated using one of the following formulas:

$$d = \frac{\overline{X}_1 - \overline{X}_2}{S_{within}}$$

$$d = \frac{2r}{\sqrt{1-r}}$$

$$d = \frac{t}{\sqrt{2n}}$$

$$d = \sqrt{\frac{F}{2n}}$$

Information:
d	: effect size
$\overline{X}_1 - \overline{X}_2$	: sample average of two groups
S_{within}	: standard deviation of the combined samples
r	: The r test value in the research results report
t	: The t test value in the research results report
F	: F test value in the research results report
n	: The number of samples in the research report

The effect size value categories use Cohen's categories as follows.

Table 1. Effect Size Value Category

Interval	Category
$0 < d \leq 0.20$	Small Effect
$0.20 < d \leq 0.50$	Medium Effect
$0.50 < d \leq 0.80$	Large Effect
$d > 0.80$	Very Large Effect

After obtaining the effect size value for each research report, the next step is to determine the average effect size value (summary effect). Determining the summary effect can use a fixed model effect. The formula is as follows:

$$M = \frac{\sum_{i=1}^{k} W_i . Y_i}{\sum_{i=1}^{k} W_i}$$

$$w_i = \frac{1}{V_{Yi}}$$

Where:

M = average effect

Y_i = effect size of the ith study

V_{Yi} = variance effect size of the ith study

Next, a hypothesis test is carried out, with the following formula:

$$Z = \frac{M}{SE_M}$$

Where:

M : the magnitude of the summery effect

SE $_M$: Standard Error value of the summery effect

The criteria for testing the hypothesis are, if the p-value <0.05 then the null hypothesis is rejected (Retnawati, Apino, Kartianom, Djidu, & Anazifa, 2018: 155). Where the p-value is obtained from:

p-value = (1-NORMDIST (Z)), for one-tailed test

p-value = 2 (1-NORMDIST (Z)), for two-tailed test

adapun hipotesis penelitian sebagai berikut:

The research hypothesis is as follows:

H_0 : There is no influence of the cooperative learning model on students' critical thinking abilities.

H_1 : There is an influence of the cooperative learning model on students' critical thinking abilities.

RESULTS AND DISCUSSION

a. Data Effect Size of the Cooperative Learning Model on Students' Critical Thinking Ability

Based on the results of data collection, 131 research reports were obtained regarding the influence of the cooperative learning model on students' critical thinking abilities. However, of the 131 research reports obtained, only 15 reports met the criteria as samples in research to determine the effect size . The report consists of 10 theses, 3 international journals and 2 national journals. The effect size data obtained from each sample is as follows:

Table 2. Effect Size for each study

No	Article Code	Writer's Name	EZ	EZ Category
1	Study 1	Irfan	0,512	Large Effect
2	Study 2	Elisa	0,268	Medium Effect
3	Study 3	Lukman Sani	0,368	Medium Effect
4	Study 4	Siti Hardianti	0,670	Large Effect
5	Study 5	Desi Sri Hidayanti	0,568	Large Effect
6	Study 6	Maximur Tamur, et. al.	0,205	Medium Effect
7	Study 7	Rohani, et. al.	0.334	Medium Effect
8	Study 8	Diana Martiana, et. al.	0,289	Medium Effect
9	Study 9	Lia Afrianti	0,291	Medium Effect
10	Study 10	Ulfa Nur Afifah, et. al.	0,254	Medium Effect
11	Study 11	Roza Oktaviana	0,380	Medium Effect
12	Study 12	Osey Putri Salehha, et. al.	0,341	Medium Effect
13	Study 13	Samsu Romansyah	0,547	Large Effect
14	Study 14	Novi Ismiasih	0,238	Medium Effect
15	Study 15	Mikke Novia Indriani	0,325	Medium Effect
	Mean effect size (summary effect)		0,37	Medium Effect

The results of the data analysis in table 1 show that there are 4 research reports with large effect size values and 11 research reports with medium effect size values. The percentage of research reports that have an effect size in the medium effect category is 73%, while research reports that have an effect size in the large effect category is 27%. The average effect size (summary effect) is 0.37 in the medium category.

Effect Size can be interpreted as the strength of the relationship or the magnitude of the difference between variables (Nindrea, 2016). The results of this research are supported by research by Sani (2018) which applies the Think Talk Write model to improve students' mathematical critical thinking skills better than conventional learning models. The cooperative learning model with different types is based on research by Rohani et al. (2022), the Think Pair Share type cooperative learning model can improve students' critical thinking abilities, where in the application of this learning model there is a think stage which involves students being independent in thinking activities. Furthermore, research by Irfan et al. (2020) stated that the Scramble learning model contributed 49% to students' critical thinking abilities. This research supports previous research which shows that there is no learning model with the effect size value obtained in the small category.

b. Data Effect Size of the Cooperative Learning Model on Students' Critical Thinking Ability Based on Educational Level

The following is data on the average effect size value of the influence of the cooperative learning model on students' critical thinking abilities based on educational level.

Table 3. Effect Size of studies based on education level

No	Educational level	Number of Research Reports	Summary effect	Category
1	Junior High School	9	0.313	Medium Effect
2	Senior High School	6	0.457	Medium Effect

Based on table 3, it is known that the cooperative learning model on students' critical thinking skills for junior high school and equivalent obtained an average effect size (summary effect) of 0.313 in the medium category. Meanwhile, for high school and equivalent levels, the average effect size (summary effect) value was 0.457 in the medium category.

If we look at it based on Cohen's category, the effect size range for the medium category is $0.20<d\leq0.50$, but if we look at the effect size value at the SMA level, it is greater than for SMP/MTs. Factors that influence the SMA/MA/SMK education level where cooperative learning models are applied more effectively than at the SMP/MTs level are that at the SMA/MA/SMK level, students are considered more mature in organizing and organizing their learning so that it is easier to follow the stages in This learning model can create a conducive learning atmosphere as expected based on the goals to be achieved. This is related to student learning readiness, both physically and psychologically. Learning readiness needs to be considered in the learning process because the learning process accompanied by learning readiness will make it easier for students to understand the material being studied. In addition, learning readiness can encourage students to respond positively and play an active role in the learning process (Ferdian et al., 2018). Furthermore, it is emphasized by Utami (2019) which states that students' cognitive maturity is formed through a continuous learning process, therefore the higher the level of student education, the more effective the learning.

c. Data Summary Effect and Z-Test

Tabel 4. Summary Effect Statistics with Fixed Effect Model

Mean and Presicion		Test of the null		Comvidence Interval (95%)	
M	SE	Z	P	Lower	Upper
0,370	0,065	5,642	<0,0001	0,241	0,498

Based on table 3 from the results of the z test data analysis in JASP, the z = 5,642; p-value < 0,05; 95% CI[0.241; 0.489]and M = 0.370. The influence of

the cooperative learning model on students' critical thinking skills is in the medium category with an average effect size or summary effect value of 0,370.

The average effect size of all studies used as research samples is 0.370 with the effect size being in the medium effect category. Thus, it is concluded that the application of the cooperative learning model in learning has an effect on students' critical thinking abilities. The cooperative learning model requires students to be actively involved in learning. In the preparation stage, students begin to ask questions and express opinions. At the scaffolding stage, through provocative questions from the teacher, students are better able to identify ideas and/or information from the material and problems provided. At the evaluation and award stage, students can carry out evaluations starting from identifying, analyzing, planning, implementing solutions, and making conclusions (Rizki dkk., 2023).

The advantage of this model is that it is very structured, because the group composition, the material discussed, the discussion steps and the final results that must be produced are all determined and controlled by the teacher. Students only follow discussion procedures designed by the teacher (Marzuki & Hakim, 2018). Therefore, in a learning process to improve students' critical thinking skills through a cooperative learning model, educators provide a problem/case which contains indicators of critical thinking skills so that in the learning process students can boost their critical thinking skills through independent learning in groups, said their respective arguments, determining conclusions together in one group, moreover, this is supported by the problem to be solved containing indicators of critical thinking.

This is in line with constructivism theory and several previous studies. Constructivism is a theory that gives freedom to those who want to learn or seek their own needs by allowing them to discover these desires or needs with the help of other people's facilities. Humans discover their abilities, knowledge or technology and develop what they need through learning. The constructivist learning process consists of building and reorganizing individual knowledge and

skills in a social context in an effort to continuously improve conceptually. According to constructivism, learning is a process of forming knowledge. This coaching must be carried out by the individual who is studying. He must be active, think actively, organize concepts and give meaning to what he learns (Saguni, 2019).

CONCLUSION

Based on the results of data analysis, the research concluded as follows the effect size of the cooperative learning model on students' critical thinking abilities as a whole has an average effect size value of 0.373, which is in the medium category. The effect size of the cooperative learning model on students' critical thinking skills based on educational level, namely, the SMP/MTs education level obtained an effect size value of 0.311 which was included in the medium category, while for the SMA/MA/SMK education level obtained an effect size value of 0.457 which was included in the medium category. Therefor, cooperative learning model influences students' critical thinking abilities.

This study makes a significant contribution to the field of mathematics education and educational research by showing that cooperative learning models can improve students' critical thinking skills, especially at the SMA/MA/SMK level. The practical implications include the need for curriculum development that better supports collaboration, teacher training in cooperative learning methods, and provision of adequate resources. Theoretically, this study strengthens the argument that cooperative learning can facilitate students' critical thinking skills through social interaction and group discussion.

However, this study also has some limitations. The generalizability of the results may be limited due to variations in school context and student characteristics. In addition, this study did not control for all outside variables that could affect the results, such as teachers' individual teaching methods and students' socio-economic backgrounds. The assumption of uniform application of cooperative learning models by all teachers and homogeneity of student groups could also be a potential bias.

Based on the findings and limitations, future research is recommended to investigate more specific cooperative learning models. Research can focus on specific variations of cooperative learning models to determine which models are most effective in improving students' critical thinking skills. In addition, the exploration of the effects of cooperative learning on different age groups or educational levels can provide deeper insights into how these strategies can be adapted for different levels of education, ranging from elementary school to college. Further research also needs to examine the impact of other factors on critical thinking skills, such as the teacher's role in facilitating cooperative learning, group dynamics, and learning environment. Finally, controlling for outside variables such as students' socio-economic background and individual teachers' teaching methods will help ensure that the results of the study are more accurate and generalizable. Future research that considers these factors will strengthen the empirical basis for the use of cooperative learning in education and help develop more effective strategies to improve students' critical thinking skills.

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