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Meta Analisis Pengaruh Penggunaan Media Pembelajaran Matematika Terhadap Kemampuan Matematis Peserta Didik

Meta-Analysis of the Effect of Using Mathematics Learning Media on Students' Mathematical Abilities.

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Abstract. *This study aims to determine : (1) The effect size of using mathematic learning media to students' mathematical abilities as a whole, (2) The effect size of using mathematics learning media to students' mathematical abilities based on level of education, (3) The effect size of using mathematics learning media to students' mathematical abilities based on learning media used, (4) The effect size of using mathematics learning media to students' mathematical abilities based on subject matter, (5) The effect size of using mathematics instructional media to students' mathematical abilities based on quantified mathematical ablility. This research used meta analysis method. The sampling technique used purposive sampling and obtained 17 research that fit the criteria. Data collection techniques used documentation with the support of software publish or perish. The results of data analysis showed that : (1) Overall using the learning media has a large effect to students' mathematical abilities as a proportion 0,972, (2) Based on level of education, the use of learning media has a largest effect size if applied at SMP/MTs as a proportion 1,039 (n=16, SD=0,754), (3) Based on learning media used, the visual media has a largest effect size to students' mathematical abilities as a proportion 1,003 (n=13, SD=0,641), (4) Based on material that is taught, the use of learning media on a branch of logic material has a largest effect size to matematical abilities as a proportion 1,237 (n=2, SD=0,489), (5) Based on quantified mathematical abilities, the use of learning media has a largest effect size to students' reasoning abilities as a proportion 1,303 (n=3, SD=0,353).*

Keywords: *Meta Analysis, Mathematics Learning Media, Mathematical Abilities*

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Abstrak. Penelitian ini bertujuan untuk mengetahui: (1) Besar pengaruh penggunaan media pembelajaran matematika terhadap kemampuan matematis peserta didik secara keseluruhan, (2) Besar pengaruh penggunaan media pembelajaran matematika terhadap kemampuan matematis berdasarkan jenjang pendidikan, (3) Besar pengaruh penggunaan media pembelajaran matematika terhadap kemampuan matematis berdasarkan media pembelajaran yang digunakan, (4) Besar pengaruh penggunaan media pembelajaran matematika terhadap kemampuan matematis berdasarkan materi yang diajarkan, (5) Besar pengaruh penggunaan media pembelajaran matematika terhadap kemampuan matematis berdasarkan kemampuan matematis yang diukur. Penelitian ini menggunakan metode meta analisis. Teknik sampling menggunakan *purposive sampling* dan didapatkan 17 penelitian yang sesuai dengan kriteria. Teknik pengumpulan data menggunakan dokumentasi dengan bantuan *software publish or perish*. Hasil analisis data menunjukkan bahwa : (1) Secara keseluruhan media pembelajaran matematika memiliki pengaruh besar terhadap kemampuan matematis peserta didik sebesar 0,972, (2) Berdasarkan jenjang pendidikan, penggunaan media pembelajaran memiliki pengaruh yang besar jika digunakan pada jenjang SMP/MTs dengan *effect size* sebesar 1,039 (n=16, SD=0,754), (3) Berdasarkan media pembelajaran yang digunakan, media visual memiliki pengaruh besar terhadap kemampuan matematis peserta didik sebesar 1,003 (n=13, SD=0,641), (4) Berdasarkan materi, penggunaan media pembelajaran dengan materi logika memiliki pengaruh besar terhadap kemampuan matematis sebesar 1,237 (n=2, SD=0,489), (5) Berdasarkan kemampuan matematis yang diukur, penggunaan media pembelajaran berpengaruh besar terhadap kemampuan penalaran matematis peserta didik yaitu sebesar 1,303 (n=3, SD=0,353),

Kata Kunci: Meta Analisis, Media Pembelajaran Matematika, Kemampuan Matematis

INTRODUCTION

Math is one of the subjects taught and is closely related to the lives of learners. Math always gets more attention from both the Indonesian government and the world. Based on the results of the Pisa test (2018) and timss (2015), Indonesia's rating is still below the average achievement rate which shows Indonesian learners have very low math scores.

Mathematical ability is an ability that can be used to solve a problem, whether it is a mathematical problem or real life. Mathematical ability includes problem solving, reasoning, connection, communication, and representation. Such ability cannot be achieved by merely teaching theory, setting an example and giving an exercise in problems without learners actively engaged in class. This process of learning will create passive learners, causing many learners to lack interest in mathematics and assume that mathematics is boring (nurjanah, 2019). Intisari (2016) of his research suggests the perceptions of mathematicians are very poor.

A use of the learning media is essential to support mathematical learning activities in the classroom. Use of learning media can increase the learning outcomes of learners (fadillah, 2018). The medium of learning is part of a resource that contains material to motivate learners in learning (wati, 2016:3). Leveraging the learning media can have a positive effect on giving information/materials that will be received by learners. The use of learning media stimulates learners' desires and interests, and contributes to the effectiveness of learning in the classroom. Much research has been done on the use of the mathematical learning media, and the results have shown that the use of the learning media optimally improves learners' mathematical ability.

Quite a number of studies are being published in journals across Indonesia in the field of education. Along with many of these studies, a systemic method called a meta analysis is required for summary reexamination of these studies. Meta-analysis uses data from other existing research (retnawati et al., 2018). The results of this research are used as ingredients to calculate an effect size. This is done to test consistency of findings because of increasing levels of similar studies and to increase variability of findings.

Many meta-analysis studies have been conducted to identify the effects of learning media use such as khaafidh (2019), yenti winataria (2018), nurlaela saadah (2022), maximus tamur (2020), mar 'atus solichah (2020), karolus (2021), and dadang juandi (2021). However, as yet no new research has been found on the meta analysis of how media use affects learners' mathematical abilities. Thus, researchers intend to do research with the title "meta research on the use of mathematics media on learners' mathematical abilities."

As for the formulation of the problem in this study, "how does the use of the mathematical learning media affect the mathematical ability of learners as a whole, based on level of education, the learning media used, the material taught and the quantified mathematical ability?"

RESEARCH METHOD

The method of research in this research is a meta analysis. The study used books, literature or journals as data sources in his research (hadi, 2006:24). Meta analysis of this research is a narrative and systematic review of an effect size from every previously published study. The population in the study is a published national thesis/journal on how the use of mathematical learning media affects the mathematical abilities of learners. With purposive sampling techniques taken should fit the following criteria: (1) it is a method of experimental research, (2) quantitative research and fulfilling statistics effect size, (3) research in Indonesia, (4) research in its time span of 2017-2021, (5) examined the impact of learning media use on the mathematics of learners (problem solving/ reasoning/ connection/ communication/ representation), (6) Education levels at junior and high school levels. The data-gathering technique used is documenting. As for the procedure in this research, that is:

1. Identifying and studying the topics to be used in research.
2. Collect literature using the publish or perish software.
3. Catalogued as much information as possible in the research reports.
4. Find an effect size using formula:

$$d = \frac{\bar{x}_1 - \bar{x}_2}{S_{within}} \quad (1)$$

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

$$V_d = \frac{n_1+n_2}{n_1 n_2} + \frac{d^2}{2(n_1+n_2)} \quad (3)$$

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

$$df = n_1 + n_2 - 2 \quad (5)$$

$$g = ES = J \times d \quad (6)$$

$$V_g = J \times V_d \quad (7)$$

$$SE_g = \sqrt{V_g} \quad (8)$$

$$SD = \sqrt{\frac{\sum_{i=1}^{n}(X_i-\bar{X})^2}{n-1}} \quad (9)$$

5. Do an analysis data with OpenMEE software.
6. Deduction and interpretation of meta analysis research.

The criteria used in an effect size interpretation using Cohen's references (becker, 2000), which is:

Small effect : $0{,}0 < ES < 0{,}5$

Medium effect: $0{,}5 \leq ES < 0{,}8$

Large effect : $0{,}8 \leq ES \leq 3{,}0$

RESULTS AND DISCUSSION

The Result of The Study

From data selection came 17 articles that fit the criteria. In these 17 articles, however, there is two article in which it has two data that can be used in calculating effect size, so in this study there are 19 effects size data from 17 articles that can be analyzed. An effect size obtained using OpenMEE's software can be seen on the following chart.

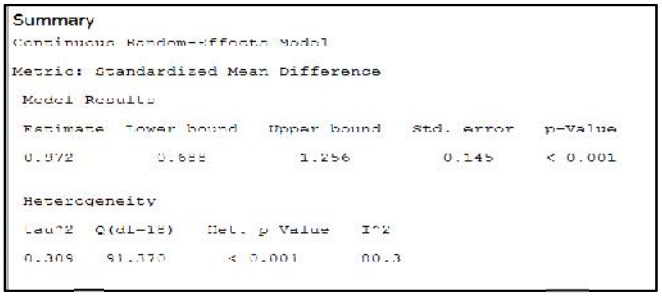
Table 1. Effect Size As a Whole

No.	Article Code	ES	Variance	Category	n Article
1	S02	0,936	0,082	Large Effect	9
2	S03	1,458	0,048		
3	S07	2,539	0,176		
4	S10	0,916	0,170		
5	S11	1,607	0,204		
6	S13	1,391	0,113		
7	S15	2,644	0,147		
8	S17	1,320	0,063		
9	S18	1,510	0,161		
10	S04	0,569	0,069	Medium Effect	5
11	S06	0,693	0,071		
12	S08	0,746	0,067		
13	S09	0,558	0,065		
14	S12	0,789	0,053		
15	S01	0,448	0,082	Small Effect	5

16	S05	0,455	0,094		
17	S14	0,434	0,051		
18	S16	0,014	0,033		
19	S19	0,449	0,065		

Table 1. shows that there are 9 data with large effect size, 5 data with a medium effect size, and 5 data with a small effect size. The biggest effect size in on the S15, while the smallest effect size is on the S16. After an eefct size is obtained, then a heterogeneity test is made to see the enormous significance of the effect size. Based on analysis through OpenMEE's software acquisition of values such as the following picture:

Figure 1. OpenMEE's Output


Summary
Continuous Random-effects Model
Metric: Standardized Mean Difference
Model Results
Estimate Lower bound Upper bound Std. error p-Value
0.972 0.688 1.256 0.145 < 0.001
Heterogeneity
tau^2 Q(df=15) Het. p Value I^2
0.309 91.370 < 0.001 80.3

From the Figure 1. can be seen that the value of $Q = 91{,}370 (Q > 0{,}05;\ p < 0.001)$. In other words, H_0 is denied. That is, the data is analyzed heterogeneous. The estimate column can see a summary effect value of 0,972. The results suggest that random effect analysis shows there is significant positive effects between the study media on the mathematics of learners. As for the impact of the learning media on learner's mathematical abilities falls in large categories ($rE = 0{,}972$).

Figure 2. OpenMEE's Forest Plot Output

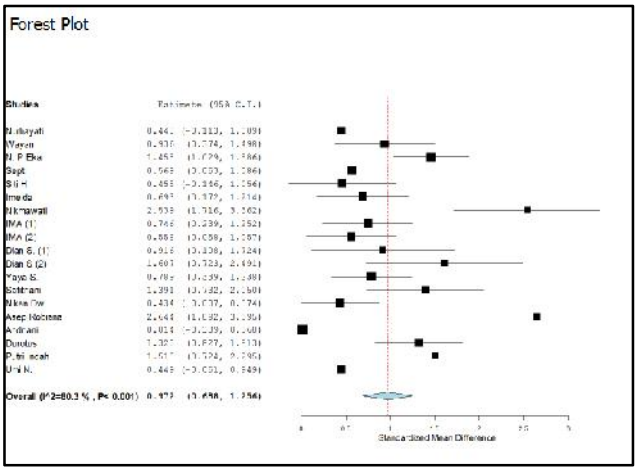


Figure 2. shows that the summary effect is 0,972, which means that math ability increased 97,2% higher for learners taught in the use of mathematical learning media than those who did not. In forest plot, it shows that the summary effect remains clear of the bottom 0 which means that the use of mathematics learning media has significant impact on learner's mathematical abilities.

Table 2. *Effect Size* Based on Education Levels

No.	Education Levels	n Article	[illegible]cation L[illegible]s	SD	Category
1.	SMP/MTs	16	1,039	0,754	Large Effect
2.	SMA/SMK/MA	3	0,704	0,123	Medium Effect

Table 2. shows that the use of the mathematics media has had a positive effect on both education levels. The highest effect size on junior school is 1,039 (n=16, SD = 0,123)

Table 3. *Effect Size* Based on Learning Media Used

No	Learning Media	n Article	[illegible]	SD	Category
1.	Media Audio Visual	6	0,917	0,895	Large Effect
2.	Media Visual	13	1,003	0,641	

Table 3. shows that the use of learning media can have a positive effect on learners' mathematical abilities. This is because each of the learning media categories falls in the large category. The highest effect size on Media Visual is 1,003 (n=13, SD=0,641).

Table 4. *Effect Size* Based on Material That is Taught

No	Lesson Material	Branch of Science	n Article	[illegible]	SD	Category
1	Aritmatika Sosial (SMP)	Arithmetic	2	0,653	0,355	Medium Effect
2	Perbandingan (SMP)					
3	Bangun Ruang Sisi Datar (SMP)	Geometry	5	0,929	0,498	Large Effect
4	Geometri (SMP)					
5	Geometri (SMA)					
6	Garis Singgung Lingkaran (SMP)					
7	Garis dan Sudut (SMP)					
8	Persamaan Garis Lurus (SMP)	Algebra	9	1,152	0,861	
9	Operasi Aljabar (SMP)					
10	SPLDV (SMP)					
11	PLSV dan PtLSV (SMP)					
12	Program Linear (SMA)					
13	PLDV (SMP)					
14	Himpunan (SMP)	Logic	2	1,237	0,489	
15	Statistika (SMP)	Statistics	1	0,014	-	Small Effect

Table 4. indicates that there are 3 branch of lesson materials in the large category, 1 branch of the lesson materials in the medium category, and 1 branch of the lesson materials in the small category. The highest effect size on a branch of logic materials of 1,237 (n=2; SD = 0,489) in the large effect category.

Table 5. *Effect Size* Based on Mathematics Ability

No.	Mathematics Ability	n Article	SD		Category
1	*Problem Solving*	11	0,894	0,652	Large Effect
2	*Reasoning*	3	1,303	0,353	
3	*Communication*	3	1,243	1,187	
4	*Representation*	2	0,655	0,923	Medium Effect

The connection ability doesn't fulfill the sample criteria, so the entry isn't in the meta analysis. Table 5. shows that the ability of problem solving, reasoning and communication are having far-reaching effects from the mathematical learning media. While representation ability have a medium effect on a mathematical learning media. The highest effect size on mathematics ability of reasoning is 1,303 (n=3, SD=0,353).

Publication Bias

The test was needed to see if the data already collected could be used as a representative sample of the population or not.

a. *Fail-Safe* N

Fail-safe n is also used to view levels of publication bias from the study. As for the OpenMEE output according to the following picture is:

Figure 3. OpenMEE File-Safe N Output

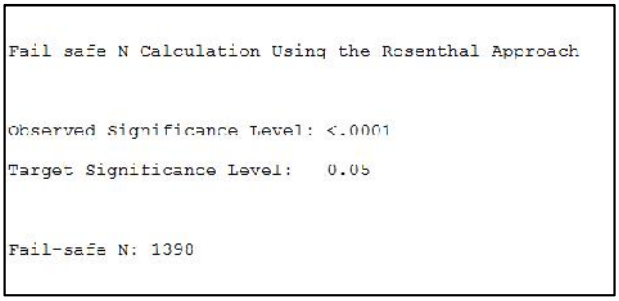


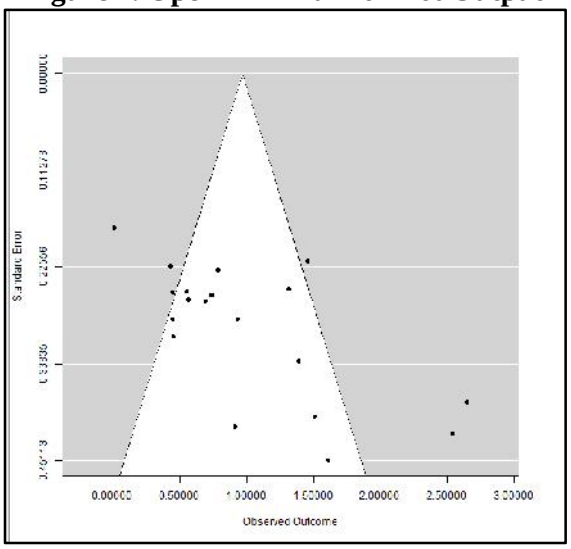
Figure 3. shows how much research was not published because of insignificant results. That picture above shows that 1398 copies of the fail-safe N value were estimated to be anywhere from 1398 biased studies or research to which the study was not published. In addition, the *fail-safe N* value will be compared with the value of $5K + 10$; ($k =$ the number of studies), with the underlying requirement if value $Fail - safe\ N > 5K + 10$, there is no publication bias. Because $K = 19$, therefore $5(19) +$

$10 = 105$, that means $Fail - safe\ N > 5K + 10$. It means, the value could be deduced that there was no publication bias in this study.

b. *Funnel Plot*

Funnel plot are used to see patterning multiple data effects in every research. As for the OpenMEE output according to the following picture is :

Figure 4. OpenMEE *Funnel Plot* Output



In that Figure 4, there was no open circle on the funnel plot of the random effect model. This may be viewed as nonexistent or unpublished research. Hence, the conclusion on the impact of the use of learning media on the math ability of free scholars from the potential publication bias. That is, the conclusions drawn from a random effect model on the use of the learning media to the mathematical abilities of learners are valid.

CONCLUSIONS

Based on data analysis obtained, it can be drawn to a conclusion, as follows:

1. On a set of 19 data plans, overall effect size showed an average effect size of 0,972is in the large category. This suggests that the learning media can have significant positive effects on learners' mathematical abilities.
2. Junior levels have an even highest mean effect size of 1,039 (n=16; SD = 0,754). While for senior high school measures 0,704 (n=3; SD = 0.123) in medium effect.

3. The media with the highest mean effect size is a visual media of 1,003 (n=13; SD =0,641).
4. The material with the highest mean effect size is logic, which is 1,237 (n=2; SD = 0,489), and statistics material has a least effect of 0.014.
5. Reasoning ability gets the most influence from the use of mathematics learning media because it obtains a mean effect size value of 1,303 (n=3, SD=0,353).

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