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Meta-Analysis of the Effect of Variety of Learning Models on Students' Mathematic Creative Thinking Ability

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Abstract
This study aims: (1) to analyze the effect size of the learning model on students' mathematical creative thinking abilities; (2) to find out the right learning model to improve students' mathematical creative thinking skills; (3) to do a meta-analysis of the influence of the learning model on the mathematical creative thinking ability of junior high school students. The data used as a meta-analysis of the selected articles are statistical data to be able to calculate the effect size and standard error. Furthermore, after passing this stage, a meta-analysis was carried out to determine heterogeneity, summary effect and evaluation of publication. Based on the results of the analysis conducted from 16 studies, it was found that 1 study had the highest effect size with the application of the Project Based Learning Model with an effect size value of 0.875. This study has the highest magnitude of influence among other studies. Furthermore, the largest effect size ranks second and third with an effect size value of 0.828 and 0.719.The project-based learning model (PBL) is considered more effective to improve the mathematical creative thinking skills of junior high school students with an effect of 0.875. The results of the meta-analysis of the learning model on students' mathematical creative thinking skills are classified in the strong category withstrong with r_{RE}= 0.455.
Keywords: Meta-analysis, Learning Model, Mathematical Creative Thinking Ability
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1. PRELIMINARY

Mathematics is a branch of science that has an important role in various aspects. Called to have an important role because the application of mathematics is used in everyday life. This is in line with Anggirena (2014) which states that everyday human life cannot be far from mathematics, be it from small things to complex technological developments. Relevant to this opinion, Daut (2016) says that mathematics as a field of science plays an important role in the development of science and technology, both as a support for the application of other fields of science and the development of mathematics itself.

According to NCTM (2000) the mathematical thinking process in mathematics learning includes five main standard competencies, namely problem solving skills, reasoning abilities, connection skills, communication skills and representation skills. Jazuli (2009:209) concludes that this low ability will result in the low quality of human resources, which is shown in the low ability to think critically and creatively. As happened in the research results, it is still found that students' mathematical creative thinking abilities are low. This is also proven through Fardah's research (2012). The conclusion of this study is the low creative thinking ability of students where the creative thinking ability of students for the high category is 6 students (20%), the medium category is 10 students (33.33%).

Based on the results of the Trend International Mathematics and Science Study (TIMMS) it is stated that the level of creative thinking ability of students in Indonesia is low because only 2% of Indonesian students can work on questions in the high and advanced categories that require creative thinking skills in solving them (Ismara, 2017: 1). This statement is in line with Alvionita's (2018) statement which states that low mathematics learning outcomes indicate something is wrong and not optimal in mathematics learning, causing students' low mathematical creative thinking skills.

Meta-analytical research itself is defined as research that uses studies that have been used by previous researchers which are carried out systematically and quantitatively. Meta-analytical research includes research that needs to be done. Besides being able to help research users in choosing the right learning model, meta-analysis research needs to be done because the research that has been done is not always perfect. To answer user questions about research results that are effective to use, researchers must look for the effect size value of each study that has been collected. Effect size itself is defined as a quantitative index used to summarize the results of the study. Based on the problems that have been described, for that researchers need to research, review the problems that arise. Therefore, researchers will conduct a meta-analysis of the influence of the learning model on students' mathematical creative thinking skills.

2. RESEARCH METHODS

2.1 Subject and Object

The subjects in this study were all research results that were used as data sources in this study, namely a

collection of articles on the influence of various learning models on students' mathematical creative thinking abilities. Meanwhile, the object of research is the influence of various learning models on students' mathematical creative thinking abilities.

2.2 Research Instruments

The instrument used in this study was a coding data sheet. The coding process will first be recorded starting from the title of the article, year of the article, name of the author, type of research, agency, article link address and article accreditation.

2.3 Data analysis

According to Becker & Park (in Ramadhani, et al, 2021:80) data analysis techniques in calculating effect size values can use several formulas such as the following:

Mean and standard deviation of two group posttest only

$$ES = \frac{\bar{X}_{E-}\bar{X}_{C}}{SD_C} \quad (1)$$

If the standard deviation is not known, the effect size can be calculated using the t-test

$$ES = t\sqrt{\frac{1}{n_E} + \frac{1}{n_C}} \quad (2)$$

Mean and standard deviation of two groups pretest-posttest

$$ES = \frac{\left(\bar{x}_{post-}\bar{x}_{pre}\right)eksperimen-\left(\bar{x}_{post-}\bar{x}_{pre}\right)kontrol}{\frac{SD_{prekontrol+SD_{preeksperimen+SD_{postkontrol}}}}{3}} \quad (3)$$

Chi-square

$$ES = \frac{2r}{\sqrt{1-r^2}};\ r = \sqrt{\frac{\chi^2}{n}} \quad (4)$$

If a study in a meta-analysis is based on the same type of data (mean, binary, or correlation), the researcher must select an effect size based on that type of data. While some studies use averages, others use binary data, and others use correlational data, then we can apply formulas to convert between effect sizes. Furthermore, Cohen (1988) provides a reference for assessing the magnitude of the effect size value, namely f = 0.1 for a small effect size, f = 0.25 for medium, and f = 0.4 for large. Furthermore, the correlation meta-analysis provides a reference for assessing the magnitude of the value. Retnawati et al, (2018:143) stated that if the value of r 0.10 then the correlation is in the "weak" category, if r = 0.25 then the correlation is in the "medium" category.

3. RESULTS AND DISCUSSION

a) Effect Size Conversion Result Data Based on Correlation Data

Table 1. Effect Size Konversi Conversion Results Based on Correlation Data

NO	ARTICLE CODE	RESEARCHER'S NAME	LEARNING MODEL USED	EFFECT SIZE (R)	DESCRIPTION
1	1A	Noviyani Florentina & Leonard	Experiment Class : Jigsaw . Cooperative Learning Model Control Class: Think Pair Share (TPS) Cooperative Learning Model	0.283	Verified
2	3A	Yenni & Silvi Elya Putri	Experiment Class : Themed Problem Based Learning Control Class : Problem Based Learning	0.340	Verified
3	4A	Ahmad Fadillah	Experiment Class : Problem Solving Learning Model Control Class : Conventional Learning	0.465	Verified

NO	ARTICLE CODE	RESEARCHER'S NAME	LEARNING MODEL USED	EFFECT SIZE (R)	DESCRIPTION
4	5A	Attin Warmi	Experiment Class: Problem Based Learning Model Control Class : Conventional Learning	0.719	Verified
5	21A	Zahrina Nurjannah & Ade Irma	Experiment Class : Creative Problem Solving Learning Model Control Class : Direct Learning Model	0.319	Verified
6	25A	Hesti Noviyana	Experiment Class : Project Based Learning Model Control Class : Conventional Learning	0.875	Verified
7	27A	Ari Septian & Riki Rizkindi	Experiment Class : Project Based Learning Model Control Class : Conventional Learning	0.828	Verified
8	28A	Gias Atikasari	Experiment Class : Cooperative Learning Model Using Think Talk Write (TTW) Strategy Control Class : Expository Learning	0.404	Verified
9	32A	Farida Maria Ulfa & Maya Asriana	Experiment Class : Project Based Learning Model Control Class : Expository Learning	0.408	Verified
10	39A	Princess Ningsih Yelni	Experiment Class : Generative Learning Model Control Class : Conventional Learning	0.375	Verified
11	40A	Muhammad Saman	Experiment Class : Model Guided Discovery Learning Control Class : Conventional Learning	0.351	Verified
12	41A	Asti Asterina	Experiment Class : Problem Centered Learning Model Control Class : Conventional Learning	0.361	Verified
13	42A	Muhammad Agung Prayogo	Experiment Class: Problem Based Learning Model Control Class : Conventional Learning	0.697	Verified
14	43A	Fatima Bilqis	Experiment Class : Learning Model Search, Solve Create and Share (SSCS) Control Class : Conventional Learning	0.056	Verified
15	44A	Rizki Fajarini Hasibuan	Experiment Class : Treffinger's Learning Model Control Class : Conventional Learning	0.526	Verified
16	47A	Imas Teti Rohaeti	Experiment Class : Treffinger's Learning Model Control Class : Conventional Learning	0.289	Verified

b) Categorization of Effect Size Learning Model Results on Improving Mathematical Creative Thinking Ability of Junior High School Students

Table 2. Data Effect Size Based on Research Independent Variables

NO	LEARNING MODEL	*EFFECT SIZE(R)*	CATEGORY
1	Jigsaw Type Cooperative Learning Model	0.283	Currently
2	Learning Model Everyone is a Teacher	0.340	Currently
3	Problem Solving Learning Model	0.465	Strong
4	Problem Based Learning Model	0.719	Strong
5	Creative Problem Solving Learning Model	0.319	Currently
6	Project Based Learning Model	0.875	Strong
7	Project Based Learning Model	0.828	Strong
8	Cooperative Learning Model Using Think Talk Write (TTW) Strategy	0.404	Strong
9	Project Based Learning Model	0.408	Strong
10	Generative Learning Model	0.375	Currently
11	Model Guided Discovery Learning	0.351	Currently
12	Problem Centered Learning Model	0.361	Currently
13	Problem Based Learning Model	0.697	Strong
14	Learning Model Search, Solve Create and Share (SSCS)	0.056	Weak
15	Treffinger's Learning Model	0.526	Strong
16	Treffinger's Learning Model	0.289	Currently

Based on the data contained in Table 2 of the various learning models applied, it appears that the one that has the biggest influence on increasing students' mathematical creative thinking skills is the Project-Based Learning Model with a large effect of 0.875.

c) Heterogeneity Test

Fixed and Random Effects

	Q	df	p
Omnibus test of Model Coefficients	68.010	1	< .001
Test of Residual Heterogeneity	50.929	15	< .001

Note. p-values are approximate.
Note. The model was estimated using Restricted ML method.

Based on the data obtained from the JASP software, the results of the analysis showed that the 16 studies analyzed were heterogeneous with large (Q=50,929; p<0.001). Thus, the model that is more suitable to be used is the random effect size model to be able to estimate the average effect size of a total of 16 studies that have met the requirements to be studied by metaanalysis.

d) Summary effect/ Mean Effect Size

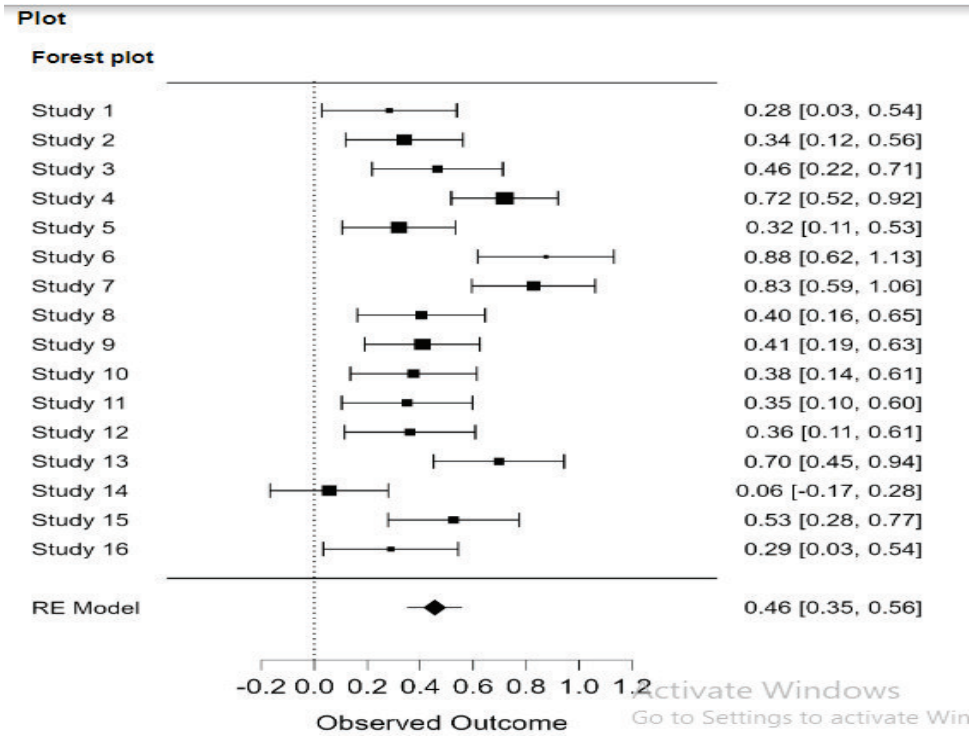
Coefficients

					95% Confidence Interval	
	Estimate	Standard Error	z	p	Lower	Upper
intercept	0.455	0.055	8.247	< .001	0.347	0.564

Note. Wald test.

Based on the results of the analysis using the random effects model, it shows that there is a significant positive correlation between the learning model on students' mathematical creative thinking skills (z=8.247; p<0.001 95% CI [0.347; 0.564]).) and the mean effect size belongs to the strong category. with rRE= 0.455.

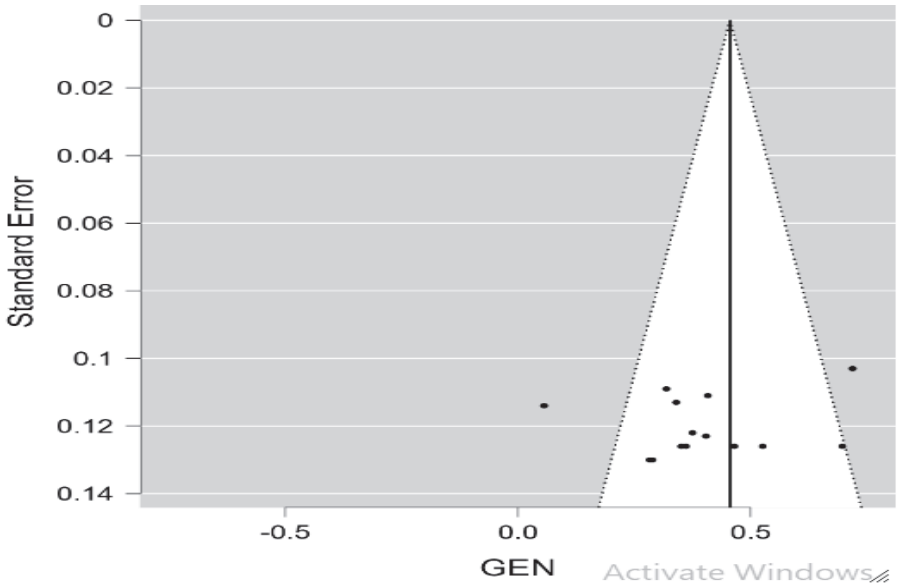
e) Forest Plot



From the forest plot, it can be observed that the effect size in these studies varies from 0.06 to 0.88.

f) Evaluation of Publication

Funnel Plot



Based on the results of the Fuunel plot above, it is difficult to conclude whether the funnel plot is symmetrical or not due to the irregular distribution of the points, so an egger's test is needed to test whether the funnel plot is symmetrical or not.

Regression test for Funnel plot asymmetry ("Egger's test")

	z	p
sei	0.220	0.826

Based on the data above, the p value 0.05. As a rule when accepting the null hypothesis that if if the p-value

0.05 then we must accept the null hypothesis (funnel plot symmetry).

4. CONCLUSION

There are sixteen studies that have met the criteria to be used as research material for meta-analysis with a strong mean effect size of 0.455. One study has the highest effect size with a value of 0.875 among other studies. The research was conducted byHesti Noviyana in 2015 with the implementation of the Project Based Learning Model. Then there is a significant positive correlation between the learning model and students' mathematical creative thinking skills (z=8.247; p<0.001 95% CI [0.347; 0.564]). For the p-value 0.05 in the Regression Test for Funnel Plot Asymmetry, there is no publication in the meta-analysis studies that have been carried out.

REFERENCES

Anggirena, A. (2014). Application of Realistic Mathematics Learning with Whole Brain Teaching on the Subject of the Pythagorean Theorem to Improve Student Learning Outcomes and Activities. UNEJ Educational Journal, 1(2): 40-46.

Becker, K. & Park, K. 2011. Effects of Integrative Approaches Among Science, Technology, Engineering and Mathematics (STEM) Subjects on Students Learning: a Preliminary Meta-Analysis. Journal of Physics: Conference Series, 1185:012093, 1-9

Cohen, J. (1988). Statistical Power Analysis for The Behavioral Science (2nd ed). Hillsdale NJ: L. Erlbaum Associates.

Daut, S. (2016). Mathematical Connection Ability in Mathematics Learning. MES Journal, 2(1):58-67.

Fardah, D. (2012). Analysis of Students' Creative Thinking Process and Ability in Mathematics Through Open-Ended Tasks. Kreano, 3(2): 1-9

Ismara, L. (2017). Students' Mathematical Creative Thinking Ability in Solving Open Ended Problems in Junior High School. Equatorial Education and Learning, 6(9): 1-8.

Jazuli, A. (2009). Creative Thinking in Mathematical Communication Skills. Paper presented at the National Seminar on Mathematics and Mathematics Education, Mathematics Education FMIPA UNY, Yogyakarta, 5 December.

National Council of Teachers of Mathematics. (2000). Curiculum and Evaluation Standards for School Mathematics. Reston, VA: National Council of Teachers of Mathematics

Ramadhani, et al. (2021). Effect Size Analysis of the Effect of LKS Application on Student Learning Outcomes in Science and Physics Learning. Journal of Science and Science Learning, 5(1): 77-89.

Retnawati, H. et al. (2018). Introduction to Mera Analysis. Yogyakarta: Parama Publishing.