e-ISSN: 2986-8076
DOI: 10.57254/tess.v2i3.41

International Journal of Geometry and Applied Mathematics
TESSERACT
Vol. 2, No. 3, Nopember 2024 Pp. 258-267
Journal Page is available at http://ekalaya.nindikayla.com/index.php/home

THE EFFECT OF CONSTRUCTIVISM-BASED LEARNING ON MATHEMATICAL ABILITY IN MATHEMATICS LEARNING: A META-ANALYSIS STUDY

Sonia Kartika[1], Fitriani[2], Sabaruddin[3]
[1,2]Institut Agama Islam Negeri Langsa, Indonesia
Email: soniaselian26@gmail.com

Abstract

This research aims to investigate the influence of constructivist-based learning on mathematical abilities in mathematics education through a meta-analysis study. The research employed a meta-analysis method by reviewing several articles with experimental test types, resulting in 15 data points that met the criteria related to constructivist-based learning and its effects on mathematical abilities in mathematics education. The Effect Size and Standard Error values were manually calculated using Microsoft Excel, and the data were analyzed using JASP software. The analysis results indicated that the 15 studies analyzed showed heterogeneity (Q=40.607, p<0.001). The Random Effect model analysis resulted in a significant outcome (z=9.023, p<0.001, 95% CI), indicating that the impact of constructivist-based learning on mathematical abilities in mathematics education falls under the high category. To address potential publication bias, the Fail-safe N value was computed using the Rosenthal formula. Since K (number of analyzed studies) was 15, the obtained Fail-safe N value was 1397 with a significance level target of 0.05 and p<0.001. As the Fail-safe N value exceeds the Fail-safe NSK value (where the criterion is Fail-safe N + 10), it can be concluded that there is no publication bias issue in this meta-analysis study.
Keywords: *constructivism, mathematics, meta-analysis, mathematical abilities.*

INTRODUCTION

The benchmark for the success of the implementation of mathematics learning can be measured by the achievement of mathematics learning objectives based on the Outline of the Teaching Program (GBPP) in the field of mathematics. GBPP states that in primary and secondary education, mathematics learning aims to enable students to face the ever-evolving changes in the world and life and train them in applying mathematics concepts to daily life. The success of mathematics learning can be seen from the success of students who participate in these learning activities. Therefore, the benchmark for the success of the implementation of mathematics learning can be seen from the extent to which the goals of mathematics learning are achieved and how much students are able to apply mathematical concepts in their daily lives.(M. A Jatisunda, 2017). In order to achieve the goal, the ability to learn mathematics, the implementation of mathematics learning can be planned by considering the development of students' understanding of mathematical concepts, their application to real situations and the development of mathematical critical thinking (Rahmah, 2013)

This is in line with the definition of mathematical ability where this ability can overcome various problems, both related to mathematics itself and in daily life. Mathematical skills include reasoning, communication, problem solving, concepts, and creative thinking and critical thinking skills (NCTM, 2000). So that it can be stated in the context of mathematics learning, mathematical skills have an important role and should be owned by every student.

But in reality, there are still many students who have low mathematical ability. This can be seen from the results of the PISA survey in 2018 in the field of mathematics. Of the total 79 countries that participated in the survey, Indonesia ranked 73rd. These results show a decrease in the performance of mathematical skills when compared to the results of the PISA survey in 2015 (Tohir, 2019). This fact shows the weak ability of students in mathematics learning (Kusmaryono, 2012). This can also be seen in Fitrian's research on the mathematical ability of junior high school students which shows that the mathematical ability of junior high school students is weak which may be caused by several things that affect the internal and external aspects of students (Fitriani, 2019).

One of the solutions to overcome this problem is through the application of learning that encourages active student involvement in the learning process. Ideally, students take center stage, and the role of the teacher changes to a facilitator who helps facilitate learning, making the student learning experience more diverse and rich (Erlinda, 2017). This approach is in line with the principle of constructivism which states that students should build their own knowledge through the learning process, rather than relying solely on information delivered by the teacher(Chujaemah, N., Yuliana, S., Utaminingsih, S., Triyono & S., 2013).

Constructivism-based learning is an approach that can encourage students to learn actively, improve their understanding, and give meaning to the information and events they experience (Ali Muhajir Siregar, 2018). In constructivism-based learning, students are placed as active subjects in learning, so that they can build their own knowledge and skills through interaction with the learning environment and can develop students' mathematical problem-solving abilities (Ali Muhajir Siregar, 2018). Constructivism-based mathematics learning emphasizes on building the students' own mathematical understanding through meaningful and interactive learning (Shuhadi, 2017). Constructivism presents a context that allows students to develop mathematical reasoning, creative thinking, critical thinking, and mathematical problem-solving.

Furthermore, a constructivist named Piaget has explained that the process of knowledge formation occurs through two main stages, namely assimilation and adaptation. In education, especially in mathematics learning, there are various problems that have become the focus of research. Therefore, several studies have been carried out through the application of constructivism-based learning to overcome these problems (Rerung, N., Sinon, I. L. S., & Widyaningsih, 2017). Meta-analysis is a quantitative and statistical analysis that provides a variety of information from some previous research data (Sukanto, 1988). Meta-analysis is a powerful technique to help find consistency and cross-validate research results. In this meta-analysis, the focus is on the study variables, size, and study participants. The aim was to analyze several studies on constructivism learning at different levels of schools.(Retnawati, 2018).

Previously, a meta-analysis study that questioned the influence of constructivism-based learning in the scope of physics learning had been conducted by Boisandi & Darmawan (2017), finding that the sample size of the initial study did not change the size of the study effect and the level of education did not affect the effect of the study (Darmawan, 2017). The similarity of this research with previous research is to find out how constructivism-based learning affects mathematical abilities in mathematics learning. Through the meta-analysis study method, this study will combine and analyze data from previous studies that have been carried out systematically and quantitatively. The goal of this commonality is to achieve a deeper understanding of the influence of constructivism-based learning to improve students' mathematical abilities. Meanwhile, the difference between previous meta-analysis research in physics learning and this metaanalysis is in mathematics learning.

RESEARCH METHODS

This study uses meta-analysis through the study of several articles published in national and international journals. The purpose of this approach is to conclude the results of the research quantitatively. (Ibrahim, 2021).

The procedure or type of research conducted in these studies involves experimental or comparative group tests. This research also involves searching and collecting journals or data through sources such as Google Scholar and Harzing's Publish or Perish which are related to constructivism-based learning on mathematical abilities in mathematics learning, then manually searching for Effect Size and Standard Error values through the use of formulas and assisted by Microsoft Excel. After that, the data that has been obtained will be analyzed using JASP software to perform a meta-analysis. The results of this analysis will be explained in the results and discussion section of the research.

The data analysis process involves the following steps: (1) Conducting a literature search through Google Scholar and Harzing's Publish or Perish to obtain information about the influence of constructivism-based learning on mathematical skills in mathematics learning. (2) Collect relevant data from the literature, including the name of the researcher, number of students (N), mean, and standard deviation or deviation (SD). (3) Calculate the Effect Size and Standard Error values manually using Microsoft Excel formulas and help. (4) Analyze data using JASP software. (5) Draw conclusions and interpret the results of meta-analyses to obtain significant findings.

RESULTS AND DISCUSSION

A total of 15 publication data that meet the criteria for this research were obtained from the search results. The data collected were in the form of research results involving the experimental group and the control group. The focus of data collection is on post-test results, namely data obtained after the application of constructivism-based learning to mathematical skills in mathematics learning. The data taken were the name of the researcher, the number of students (N), the mean, and the standard deviation or standard deviation (SD). The results of Size Effects and Standard Errors that use formulas through the help of Microsoft Excel so that the values of Size Effects and Standard Errors are obtained are contained in the table below.

Table 1. *Research Sample Data Search Results*

No.	Studies	Eksperimen			Control			Variable Moderator	
		N	**Mean**	***SD***	***N***	**Mean**	***SD***	**Jenjang**	**Mathematics Skill**
1	(Mutiarawati, 2020)	31	80,56	10,88	31	60,67	11,28	SMP	Spatial
2	(Ayuningsih, 2019) A	29	76	9,49	29	66,09	13,56	SMP	Conceptual

3	(Sanitia et al., 2022)	40	68,36	9,74	40	57,53	11,35	SD	Procedural
4	(Setialesmana, 2016)	44	13,66	3,86	44	9,59	4,12	College	General
5	(Ayuningsih, 2019)B	29	67,68	12,79	29	66,09	13,56	SMP	Conceptual
6	(Ernawati, 2019)	25	85,4	7,03	25	70,78	5,84	SMP	Other
7	(Mahendra, 2016)	21	77,85	9,02	22	68,18	8,94	SMP	Spatial
8	(Suryati, 2017)	40	82,3	13,09	40	63,3	10,46	SMP	General
9	(Febriyanti, 2014)	43	65,71	14,03	43	54,2	11,96	SMP	General
10	(Tahir, 2019)	21	77,95	6,72	17	74,18	7,26	SMP	Other
11	(Suani, 2013)	35	76,71	10,92	35	64,43	10,73	SMA	Other
12	(Jatisunda, 2017)	35	26,51	6,86	35	20,84	7,89	SMP	Problem-solving
13	(Rahmawati, 2013)	34	71,98	9,86	34	63,41	8,87	SD	Representation
14	(Palapasari et al., 2017)	40	81,92	12,99	40	68,5	11,16	SMP	Problem-solving
15	(Rahayu, 2009)	70	18,31	2,2	70	15,14	2,78	SMK	Representation

Table 2. *Statistical Data of JAS Input Samples (ES and SE Assisted by Microsoft Excel)*

No	Study Name	Eksperimen			Control				
		N	**Mean**	***SD***	***N***	**Mean**	***SD***	**Size Effect**	**S Error**
1	(Mutiarawati, 2020)	31	80,56	10,88	31	60,67	11,28	**1,772**	**0,299**
2	(Ayuningsih, 2019) A	29	76	9,49	29	66,09	13,56	**0,835**	**0,272**
3	(Sanitia et al., 2022)	40	68,36	9,74	40	57,53	11,35	**1,014**	**0,237**
4	(Setialesmana, 2016)	44	13,66	3,86	44	9,59	4,12	**1,011**	**0,226**
5	(Ayuningsih, 2019)B	29	67,68	12,79	29	66,09	13,56	**0,119**	**0,261**
6	(Ernawati, 2019)	25	85,4	7,03	25	70,78	5,84	**2,227**	**0,359**
7	(Mahendra, 2016)	21	77,85	9,02	22	68,18	8,94	**1,057**	**0,323**
8	(Suryati, 2017)	40	82,3	13,09	40	63,3	10,46	**1,588**	**0,256**
9	(Febriyanti, 2014)	4	65,7	14,0	4	54,2	11,9	**0,875**	**0,225**

		3	1	3	3		6		
10	(Tahir, 2019)	21	77,95	6,72	17	74,18	7,26	**0,53**	**0,329**
11	(Suani, 2013)	35	76,71	10,92	35	64,43	10,73	**1,122**	**0,256**
12	(Jatisunda, 2017)	35	26,51	6,86	35	20,84	7,89	**0,758**	**0,246**
13	(Rahmawati, 2013)	34	71,98	9,86	34	63,41	8,87	**0,903**	**0,253**
14	(Palapasari et al., 2017)	40	81,92	12,99	40	68,5	11,16	**1,098**	**0,239**
15	(Rahayu, 2009)	70	18,31	2,2	70	15,14	2,78	**1,258**	**0,185**

Furthermore, the data obtained were subjected to a heterogeneity, summery effect/mean effect size test, and publication bias test on meta-analysis using JASP software.

Table 3. *Heterogeneity Test Results*

Fixed and Random Effects			
	Q	**df**	**p**
Omnibus test of Model Coefficients	81.410	1	< .001
Test of Residual Heterogeneity	40.607	14	< .001

Heterogeneity test is a statistical method used to determine whether the variation between groups or populations being compared is significant or not (Retnawati, 2018). The goal is to identify significant differences between the groups in the characteristics being observed. In Table 3, the results of the size effect analysis from the 15 studies analyzed show heterogeneity (Q=40.607, p<0.001). Therefore, the Random Effect model is more appropriate for estimating the average effect size of these studies.

Tabel 4. *Summery Effect/Mean Effect Size*

Coefficients						
					95% Confidence Interval	
	Estimate	**Standard Error**	**with**	**p**	**Lower**	**Upper**
intercept	1.062	0.118	9.023	< .001	0.832	1.293
Note. Wald test.						

Summary Effect/Mean Effect Size, in the context of meta-analysis, refers to the average effect size calculated from the results of the study included in the analysis.(Cooper, 2019). In Table 4, the results of the analysis using a random-effects model show that there is a significant positive relationship between constructivism-based learning and mathematical ability (z = 9.023; p<0.001, 95% CI (0.832; 1.293]). Thus, the influence of constructivism-based learning on mathematical abilities in mathematics learning is included in the high category.(Cohen, 1988). Next, the Publication Bias Test the researcher used the JASP output loaded on the Forest Plot and Funnel Plot images.

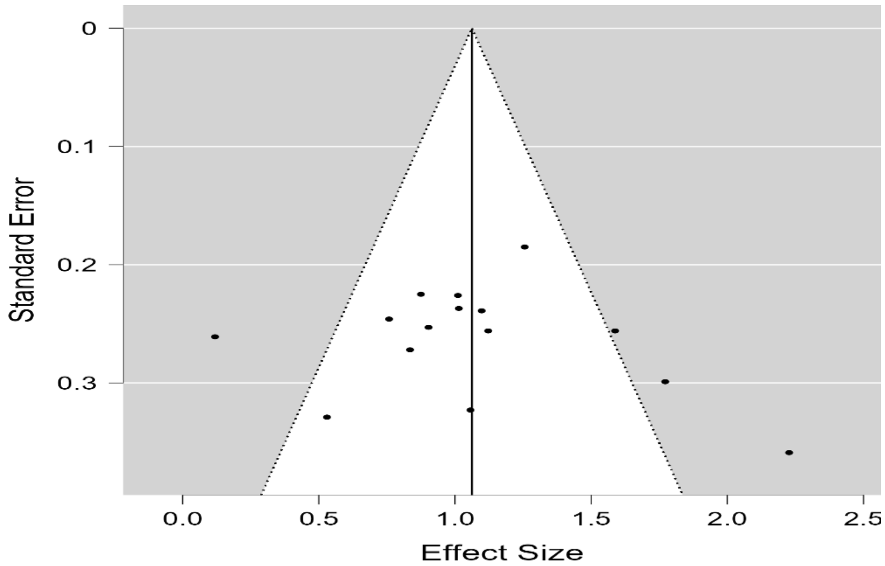

Image1Forest Plot

Figure 1, in the forest plot, it can be seen that there are 15 articles that are analyzed to calculate the size effect. Each article is represented by a black box that shows the size effect on each article. The value of the size effect varied, with the lowest value of 0.12 in Ayuningsih B's research article and the highest value of 2.23 in Ernawati's research article. Overall, the size effect values of all the analyzed studies were shown by a diamond-shaped box with a value of 1.06 and an upper limit of 1.29 and a lower limit of 0.83.

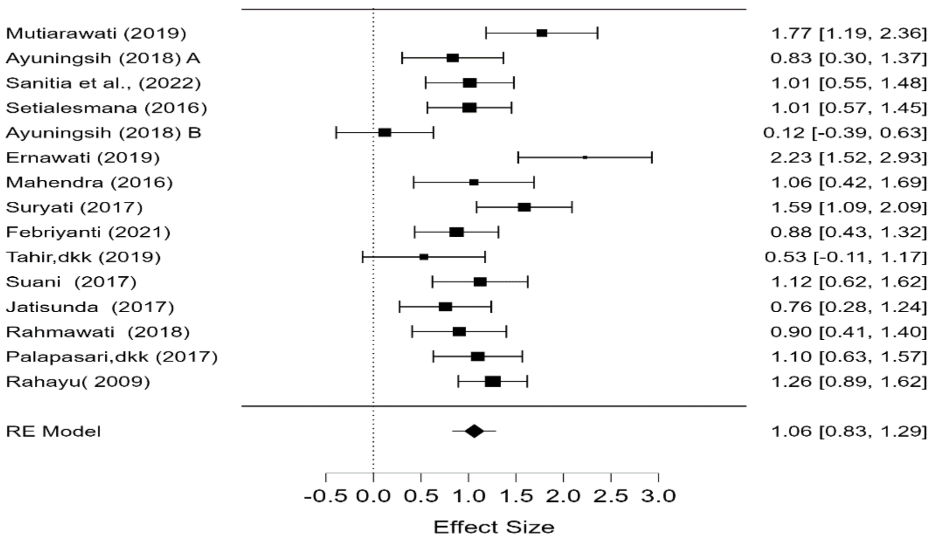

Figure 2
Funnel Plot

The results of the funnel plot in Figure 2 show a symmetrical shape with the sample points of each item and process within a triangular area. To improve the accuracy of the plot funnel test results above, the Egger's Test is as follows.

Table 5. Egger's Test

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

	with	**p**
may be	0.990	0.322

From Table 5, it can be seen that the z value is 0.990 with a value of p = 0.322 which is greater than the significance value of 0.05. This confirms that the funnel plot has a symmetrical shape. From this it can be concluded that there is no problem of publication bias in meta-analytical studies.

Table 6. Fail – safe N

File Drawer Analysis

	Fail-safe N	**Target Significance**	**Observed Significance**
Rosenthal	1397.000	0.050	<.001

Table 6, using the Rosenthal formula, where K=15, then 5K+10=5(15)+10=85. The results obtained were a safe N-value of 1397,000 with a target significance level of 0.05 and p<0.001. Since the safe N score is greater than 85 (SK + 10), it can be concluded that there was no publication bias issues in this meta-analysis study.

From this explanation, it can be concluded that the results of the study show that constructivist learning has an impact on mathematical skills in mathematics learning. This can be seen from the effect size value of 1.062 which is included in the high category, and is not a publication bias issue in this meta-analysis study. The results of this meta-analysis also support the results of previous research. Therefore, it can be concluded that constructivist learning has the potential to improve students' mathematical skills.

This research has relevance to the research conducted by Boisandi and Handy Darmawan (2017) entitled "Metaanalysis of the Influence of Learning Application on Physics Materials in West Kalimantan." In this study, the results were obtained that the average learning based on constructivism measured by actions that are included in the "good" category has a positive effect on the subject dependent variables that are also included in the "good" category. These results show that constructivism learning has a significant influence on problem-solving skills. Similarly, research by (Widana, 2021) indicates that there is a considerable difference in the effect size and interval value of each article. One of the factors causing the variation is the relatively small number of research samples. However, when the effect size was combined with a larger sample count, the results showed that the overall effect size was in the medium range of effectiveness. This indicates that the effect of constructivism-based learning on mathematical ability has a significant impact in general.

CONCLUSION

Based on the results of the study, it can be concluded that the analysis using the random effect model showed a significant positive correlation between constructivism-based learning and mathematical ability (z=9.023; p<0.001, 95% CI (0.832, 1.293]) and there was no publication bias problem in this meta-analysis study. As a suggestion, in the application of constructivism-based mathematics learning, constructivism measures must be followed well. This is important to ensure that constructivism-based learning can run effectively and optimally. Thus, learning mathematics will become more meaningful and effective for students.

BIBLIOGRAPHY

Ali Muhajir Siregar. (2018). *Kemampuan Pemecahan Masalah Matematis Siswa*. *1*(3), 1–10.

Ayuningsih, L. (2019). *Pengaruh Model Pembelajaran Konstruktivisme Tipe Novick Terhadap Kemampuan Pemahaman Konsep Matematika Siswa MTs Al-Muhajjirin Panjang Tahun* …. http://repository.radenintan.ac.id/6556/1/SKRIPSI_FULL.pdf

Chujaemah, N., Yuliana, S., Utaminingsih, S., Triyono, & B., & S., H. (2013). Penggunaan Pendekatan Konstruktivisme dalam Peningkatan Hasil Belajar Matematika Siswa Kelas IV Materi Bangun Ruan. *Kalam Cendekia PGSD Kebumen*, *1*(2), 1–7.

Cohen, J. (1988). Statistical Power Analysis for the Behavioral Sciences. *Routledge*.

Cooper, H. (2019). The Handbook of Research Synthesis and Meta-Analysis. *Russell Sage Foundation*.

Darmawan, H. (2017). *Meta Analisis Pengaruh Penerapan Pembelajaran Berbasis Konstruktivisme Pada Pembelajaran Fisika Di Kalimantan Barat*. *06*(2), 179–185. https://doi.org/10.24042/jipfalbiruni.v6i2.1762

Erlinda, N. (2017). Peningkatan Aktivitas dan Hasil Belajar Siswa melalui Model Kooperatif Tipe Team Game Tournament pada Mata Pelajaran Fisika di SMK. *Tadris: Jurnal Keguruan Dan Ilmu Tarbiyah*, *2*(1), 47–52.

Ernawati. (2019). Pengaruh Pendekatan Konstruktivisme Setting Kooperatif Terhadap Hasil Belajar Matematika Siswa Kelas VIII Smp Negeri 1 Banda. *Jurnal Ilmu Pendidikan Dan Humaniora*, *5*, 12–19.

Febriyanti, D. (2014). Pengaruh pendekatan konstruktivisme strategi react terhadap kemampuan pemahaman relasional matematis siswa. *UIN Syarif Hidayatullah Jakarta*, 1–77.

Fitriani. (2019). Kemampuan Pemecahan Masalah Siswa SMP. *Tadris Matematika*, *01*(01), 25–30.

Ibrahim, M. (2021). Penerapan Metode Pembelajaran Blended Learning Dalam Meningkatkan Pemahaman Konsep Hasil Belajar Siswa : Sebuah Meta-analisis. *Al Khawarizmi: Jurnal Pendidikan Dan Pembelajaran Matematika*, *5*(1), 48–63.

Jatisunda, M. G. (2017). Pengaruh Pendekatan Konstruktivisme terhadap Pemecahan Masalah Matematik Peserta Didik (Studi Quasi Eksperimen terhadap Peserta Didik Kelas VIII SMP Negeri 1 Talaga Tahun Pelajaran

2015/2016). *Jurnal Theorems*, *2*(1). https://doi.org/10.31949/th.v2i1.574

Kusmaryono, I. (2012). Pembelajaran Matematika Konstruktivisme Berorientasi Hands On Mathematics. *Seminar Nasional Pendidikan Matematika Di Universitas Negeri Malang*.

M. A Jatisunda. (2017). Penerapan Pendekatan Konstruktivisme dalam Pembelajaran Matematika untuk Meningkatkan Kemampuan Pemecahan Masalah Siswa. . . *Jurnal Tadris Matematika*, *1*, 47–54.

Mahendra, C. (2016). *Pengaruh Pendekatan Konstruktivisme Terhadap Sikap Pada Matematika Dan Hasil Belajar Matematika Kelas Siswa IX Smp Pangudi Luhur Salatiga*. 1–23.

Mutiarawati, A. (2020). Pengaruh Pendekatan Konstruktivisme Terhadap Karakter Kepercayaan Diri Siswa dalam Pembelajaran Matematika di SMPN 15 Kota Bekasi. *Jurnal Pendidikan Mipa*, *9*(2), 116–122. https://doi.org/10.37630/jpm.v9i2.228

NCTM. (2000). Principles and Standards for School Mathematics. *United States of America*.

Palapasari, R., Kadir, & Anggo, M. (2017). Pengaruh Penerapan Konstruktivis Realistik Dan Kemampuan Dasar. *Jurnal Pendidikan Matematika*, *8*(1), 46–56.

Rahayu, E. (2009). Pembelajaran Konstruktivisme Ditinjau Dari Gaya Belajar Siswa. *Prosiding Seminar Nasional Matematika Dan Pendidikan Matematika*, *September*, 978–979. http://www.webometrics.info.

Rahmah, N. (2013). Hakikat Pendidikan Matematika. *Al-Khwarizmi*, *2*, 1–10.

Rahmawati, F. (2013). Pengaruh Pendekatan Pendidikan Realistik Matematika dalam Meningkatkan Kemampuan Komunikasi Matematis Siswa Sekolah Dasar. *Prosiding SEMIRATA 2013*, *1*(1), 225–238. http://jurnal.fmipa.unila.ac.id/index.php/semirata/article/view/882

Rerung, N., Sinon, I. L. S., & Widyaningsih, S. W. (2017). Penerapan Model Pembelajaran Problem Based Learning (PBL) untuk Meningkatkan Hasil Belajar Peserta Didik SMA pada Materi Usaha dan Energi. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, 47–55.

Retnawati, H. dkk. (2018). *Pengantar Analisis Meta* (Ezi Apino (ed.); pertama). Parama Publishing. http://staffnew.uny.ac.id/upload/132255129/pendidikan/Ch1-2 Pengantar Analisis Meta.pdf

Sanitia, Lisbet N. Sihombing, & Hetdy Sitio. (2022). Pengaruh Pendekatan Konstruktivisme terhadap Hasil Belajar pada Subtema 2 Kebersamaan dalam Keberagaman Kelas IV SD Negeri Sinaksak. *Tematik: Jurnal Penelitian Pendidikan Dasar*, *1*(1), 110–114. https://doi.org/10.57251/tem.v1i1.615

Setialesmana, D. (2016). Pengaruh penggunaan pendekatan konstruktivisme terhadap kemampuan berpikir kritis matematik mahasiswa. *Jurnal Penelitian Pendidikan Dan Pengajaran Matematika*, *2*(2), 99–106.

Shuhadi, A. (2017). Effects of constructivist learning on mathematics achievement: A meta-analysis study. *Mathematics Education*, *8*(2), 171.

Suani, E. (2013). *Pengaruh Pendekatan Konstruktivis terhadap Hasil Belajar Matematika Siswa Sman 2 Siak Hulu Kampar*. 1–70. https://repository.uin-suska.ac.id/2141/1/2013_2013825PMT.pdf

Sukanto. (1988). *Perencanaan & Pengembangan Kurikulum Pendidikan Teknologi dan Kejuruan.*

Suryati, W. (2017). *Pengaruh Pendekatan Pembelajaran Konstruktivisme Terhadap Keterampilan Berpikir Kreatif Siswa Pada Mata Pelajaran Matematika di SMP Nurul Iman Palembang*.

Tahir. (2019). Pengaruh Model Pembelajaran Discovery Learning dengan Pendekatan Konstruktivisme Terhadap Hasil Belajar. *Jurnal Ilmiah Sekolah Dasar*, *3*(2), 246. https://doi.org/10.23887/jisd.v3i2.18055

Tohir, M. (2019). *Hasil PISA Indonesia Tahun 2018 Turun Dibanding Tahun 2015*. 2018–2019.

Widana, I. W. (2021). Realistic Mathematics Education (RME) untuk Meningkatkan Kemampuan Pemecahan Masalah Matematis Siswa di Indonesia. *Jurnal Elemen*, *7*(2), 450–462. https://doi.org/10.29408/jel.v7i2.3744