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DO COMBINATION LEARNING MODELS CHANGE THE STUDY EFFECT SIZE? A META-ANALYSIS OF CONTEXTUAL TEACHING AND LEARNING

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Abstract

Evidence-based research on the effects of Contextual Teaching-Learning (CTL) on mathematical abilities has been conducted. However, whether different combinations of learning can change the studies' effect size has not been explored. In order to fill this gap, it is necessary to conduct a meta-analysis study that can summarize the evidence on the effects of CTL and analyze how differences in learning combinations are related to the effect size (ES) of the study. The research sample is an individual study of the effects of CTL on various mathematical abilities identified from the ERIC database, the Scopus database, and Google Scholar. Based on the eligibility requirements, 26 studies were included in the analysis. The estimation method uses the random-effect model, and the Comprehensive Meta-Analysis (CMA) is used as a data processing tool. The analysis results showed that the ES of the study was 0.88. This show indicates overall, the use of CTL has a major significant on students' mathematical abilities. The results of further analysis explained that differences in the combination of learning moderated the implementation of CTL. These findings provide information to teachers and other related parties that CTL, combined with other methods, needs to be developed.

Keywords: Meta-Analysis, Contextual Teaching-Learning, Mathematical Abilities, Combination Learning Model, Effect Size

Abstrak

Penelitian berbasis bukti tentang pengaruh Contextual Teaching-Learning (CTL) terhadap kemampuan matematika telah dilakukan. Namun, apakah kombinasi pembelajaran yang berbeda dapat mengubah ukuran efek studi belum dieksplorasi. Untuk mengisi kesenjangan tersebut, perlu dilakukan studi meta-analisis yang dapat merangkum bukti-bukti tentang pengaruh CTL dan menganalisis bagaimana perbedaan kombinasi pembelajaran dikaitkan dengan effect size (ES) dari penelitian tersebut. Sampel penelitian adalah studi individu tentang efek CTL pada berbagai kemampuan matematika yang diidentifikasi dari database ERIC, database Scopus, dan Google Scholar. Berdasarkan persyaratan kelayakan, 26 studi dimasukkan dalam analisis. Metode estimasi menggunakan model random-effect, dan Comprehensive Meta-Analysis (CMA) digunakan sebagai alat pengolah data. Hasil analisis menunjukkan bahwa ES penelitian adalah 0,88. Hal ini menunjukkan secara keseluruhan, penggunaan CTL memiliki pengaruh yang signifikan terhadap kemampuan matematika siswa. Hasil analisis lebih lanjut menjelaskan bahwa perbedaan kombinasi pembelajaran memoderasi penerapan CTL. Temuan ini memberikan informasi kepada guru dan pihak terkait lainnya bahwa CTL yang dikombinasikan dengan metode lain perlu dikembangkan.

Kata Kunci: Meta-analysis, Contextual Teaching-Learning, Kemampuan Matematis, Kombinasi Model Pembelajaran, Ukuran Efek

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INTRODUCTION

Research that questions the effect of Contextual Teaching-Learning on mathematical ability has been studied more than once by different research teams in different places, and by different participants. In many cases, the results of some of these individual studies are mixed and even contradictory (eg., Tamur, 2012; Setiawan & Harta, 2014; Surya, Putri, & Mukhtar, 2017; Kurnila, Tamur, Ramda, & Parinters, 2018; Jehadus et al., 2020; Kistian, Fahreza, & Mulyadi, 2020; Mamartohiroh, Muhandaz, & Revita, 2020; Nurjanah, Latif, Yuliardi, & Tamur, 2020; Pereira, Huang, Chen, Hermita, & Tamur, 2020). Failure to identify most of the existing research results in certain literature or databases has the potential to build wrong conclusions (Franzen, 2020; Tamur, Juandi, & Kusumah, 2020). The need to arrive at conclusions that influence the future practice of CTL implementation is driving momentum towards "evidence-based research".

In line with that, recently, meta-analyzes, which are evidence-based research, are increasingly being carried out. Meta-analyses were conducted to summarize the population's evidence (Lee, 2019; Tamur, Jehadus, Negara, Siagian, Marzuki, Sulastri, 2021). Meta-analysis provides accurate and convincing conclusions (Siddaway, Wood, & Hedges, 2019; Juandi et al., 2021; Khan, 2020). Thus, in order to achieve more objective results and form the basis of decisions, a meta-analysis of the effect of CTL as a whole is absolutely necessary.

Although several related meta-analyses have been carried out (e.g., Tamur, Juandi, & Adem, 2020; Tamur & Juandi, 2020; Susanti, Juandi, & Tamur, 2020; Paloloang, Juandi, Tamur, Paloloang, & Adem, 2020); Yunita, Juandi, Tamur, Adem, & Pereira, 2020; Suparman, Juandi, & Tamur, 2021) to test various learning effects on mathematical abilities, only Tamur, Jehadus, Nendi, Mandur, & Murni (2020) specifically evaluated the effects of CTL. However, the previous meta-analysis of the effects of CTL was limited to students' comprehension abilities. To date, it has not been explored about the overall effect of CTL on various mathematical abilities and the extent to which different combinations of learning models moderate the effect sizes of the studies.

This meta-analysis study extends and complements previous research by analyzing the relationship between different combinations of learning models used and the study's effect size. These findings will contribute to the literature providing important information for the further development of CTL. To achieve the research objectives, these two questions were examined: first, whether the effect size of CTL has a significant impact on students' mathematical abilities. Second, to what extent do different combinations of learning models moderate the effect sizes of the studies?

METHOD

This study is a meta-analysis that combines various individual studies of the effects of CTL on mathematical ability. As in general, the application of the meta-analysis methodology described by Pigott (2012) and Glass (2015) has been conducted using three stages: determining inclusion criteria, collecting data and coding variables, and implementing statistical analysis.

First, the inclusion criteria were determined, taking into account the research objectives. In this study, individual studies that are considered suitable for analysis must meet the criteria, namely; (a) in the form of accredited national journals and international journals; (b) present the results of a study on the effects of CTL; (c) publication in the last 10 years; and (d) contains statistical information for the calculation of the effect size (ES).

Second, data collection and variable coding were determined. This study uses an electronic database to search for individual studies, including ERIC (Education Resources Information Center), Scopus database, and Google Scholar. Based on Pigott & Polanin (2020) recommendation regarding a transparent and quality data selection process, the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyzes) protocol is implemented. This protocol was initiated to identify 341 articles collected from the associated database. Then it was screened to find 94 articles that were removed due to duplication. Next, the eligibility stage is applied, namely selecting articles based on inclusion criteria. This stage excludes 281 articles from the analysis and recommends 26 individual studies to be included in this analysis.

A research instrument is a coding form developed to extract information from 26 individual studies into numerical data, which includes, author's name, learning model combinations, and statistical information for effect size transformations. The reliability of the coding process was ascertained by involving two independent researchers to code 26 studies. The reliability test used the Cappa Cohen coefficient (κ (7)), which is a strong statistic for testing the level of agreement between coders (McHugh, 2012). Cohen's kappa formula is; κ (7) = (Pr (a) -Pr (e)) / (1-Pr (e)) where Pr (a) represents actually observable agreement, and Pr (e) represents coincidence agreement. A value of 0.85 or greater is pre-determined to be considered high. The agreement rate in the study was 0.91 which means, there was a substantial match between coders. This reflects that this research is reliable.

Third, statistical analysis is applied where ES as the unit of analysis reflects the magnitude of the influence of CTL on students' mathematical abilities. Comprehensive Meta-Analysis (CMA) is used to assist data processing and measurement scales based on the Hedges'g equation. ES interpretation uses Cohen (1988) classification, namely, less than 0.2 (ignored), between 0.2 and 0.5 (small effect), between 0.5 and 0.8 (moderate effect), between 0.8, and 1.3 (large effect), and more than 1.3 (excellent effect). The estimation method uses a random-effect model because it does not assume that all studies estimate the same true effect (Pigott, 2012). The null hypothesis (h0), which states that all research results are the same (homogeneous), is rejected if the p-value is <0.05, which means that the ES between studies or study groups is different (Borenstein, Hedges, Higgins, & Rothstein, 2009). Funnel plots and FSN tests were used to reveal the effect of publication bias.

RESULTS AND DISCUSSION

Research Findings Regarding the First Sub-Question

First, this study is expected to reveal the magnitude of CTL's effect on students' mathematical abilities. Based on the collating data results using the CMA, Figure 1 presents a plot of forest ES size for each study.

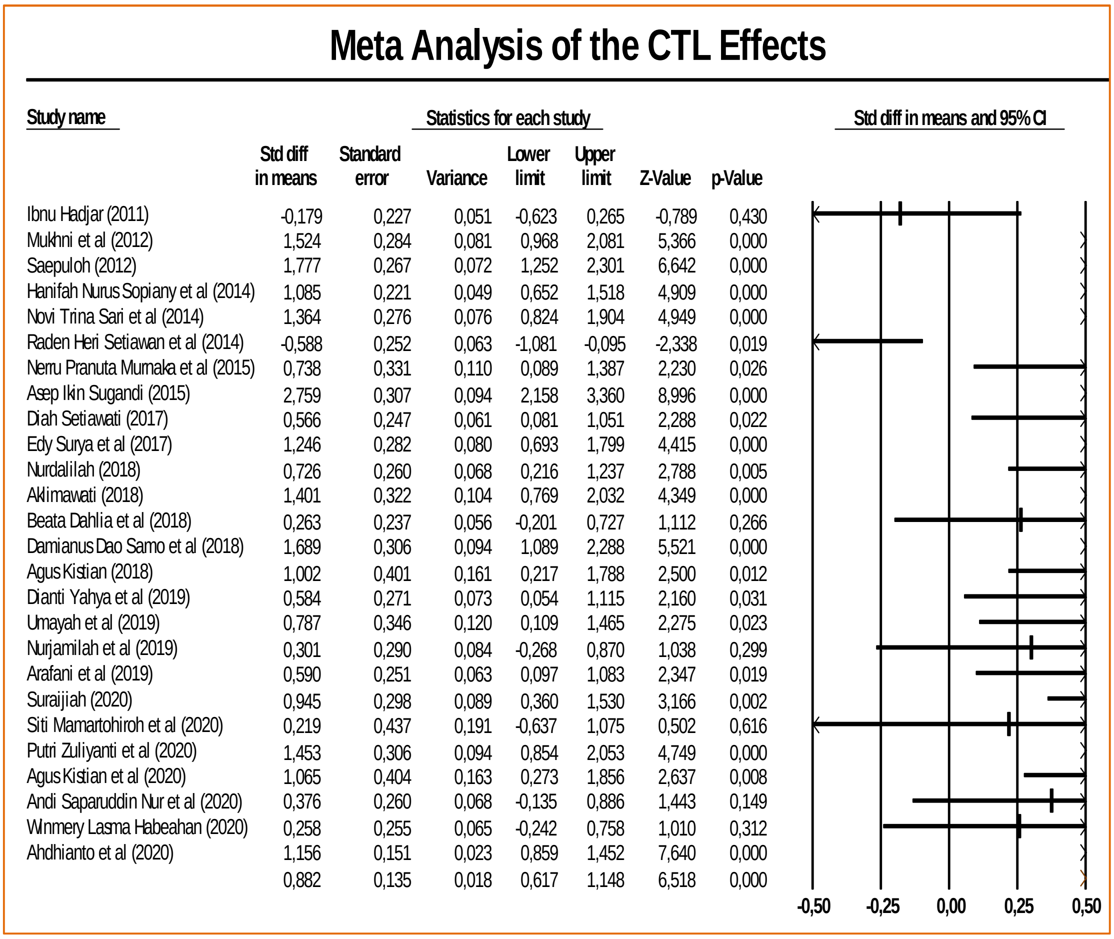

Figure 1. Distribution of effect sizes and classification

Figure 1 illustrates that the ES of each study from the application of CTL provides a varied distribution of ES. As the research findings of Tamur, Jehadus, Nendi, et al. (2020), these results suggest that many moderators moderate the ES studies. Thus, further analysis needs to be carried out to see the extent to which the moderator's influence is related to ES studies (Arik & Yilmaz, 2020). However, beforehand the estimation model needs to be tested whether it fits the random effects model or not. As seen in Figure 1, the combined ES was 0.88 with the ES range for each study [-0.5-0.5]. Table 1 shows the comparison of the results based on the estimation method.

Table 1. Research results according to the estimation method

Model	N	Hedges's g	Standard error	95% Confidence Interval		Q	P	Decision
				Lower	Upper			
Fixed-effect	26	0.85	0.05	0.74	0.96	159.41	0.00	Reject h_0
Random-effect	26	0.88	0.13	0.61	1.14			

Table 1 shows that the p-value <0.05 means heterogeneous ES distribution, reflecting that the estimation model fits the random-effects model. Thus the ES study referred to a random-effect model of 0.88. Next, to check for publication bias, the study funnel plots in Figure 2 were included. Resistant to publication bias when ES studies are distributed symmetrically (Borenstein et al., 2009). The FSN test was used when the 26 ES studies were not completely symmetrical. If k is the number of studies analyzed, then an FSN number / (5k + 10) <1 is considered resistant to publication bias (Mullen, Muellerleile, & Bryant, 2001).

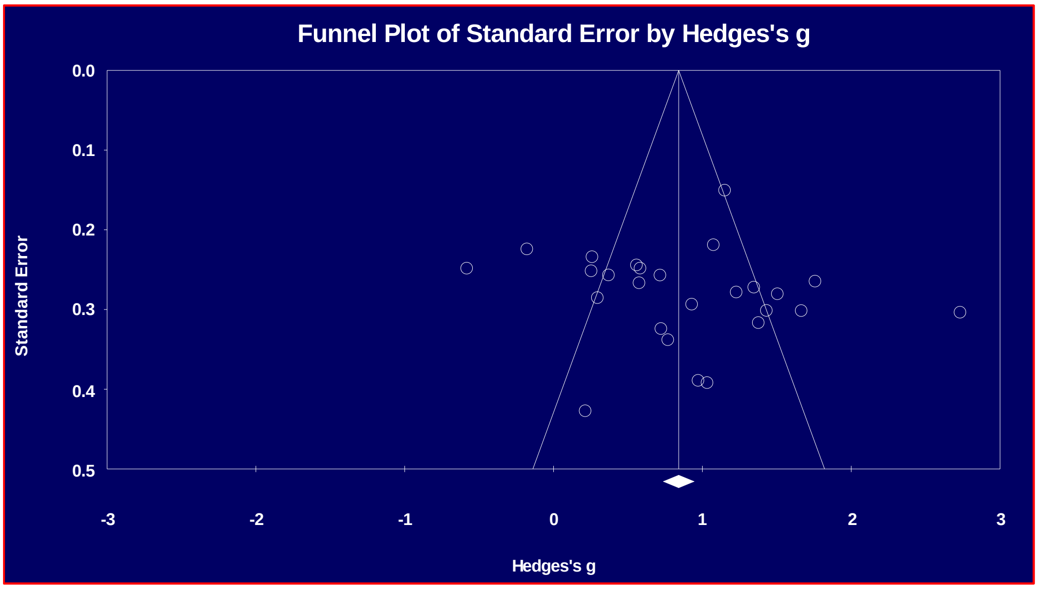

Figure 2. Research funnel plot

Figure 2 illustrates that the ES distribution of each study is not entirely symmetrical between the vertical lines. Therefore, it is necessary to apply the FSN test to evaluate the extent of the effects associated with publication bias, and the results are presented in Table 3.

Tabel 3. Rosenthal's FSN Statistics Results

Classic fail-safe N	
The z value for observed studies	16.06
The P-value for observed studies	0.00
Alpha	0.05
Tails	2
The z value for Alpha	1.96
Number of Observed Studies	26
FSN	1721

Table 3 shows, the FSN value is 1721. Based on the Mullen formula, the calculation result of 1721 / (5 * 26 + 10) is 12.19> 1. This reflects that the analyzed study is resistant to publication bias. Thus, this study's results are not influenced by sample bias from individual studies, which can obscure the ES studies.

Research Findings Regarding the Second Sub-Question

This study considers different combinations of learning models as moderator variables. The aim was to examine the extent to which combination learning models moderate ES studies. The coding of the individual studies resulted in two subgroups associated with the combination of the learning model. The first group was an individual study with only 17 (65%) of CTL applied. The second group is a study of individuals who apply CTL combined with other methods (CTL + Another method) as many as 9 (35%). A summary of the results of the moderator analysis is presented in Table 4.

Table 4. Results of mediator variable analysis

Mediator Variable	Group	N	Hedge's g	Heterogeneity (Q_b)	df(Q)	P	Decision
Combination of learning models	Only CTL	17	0.71	14.89	1	0.00	Reject h_0
	CTL + Another method	9	1.13				

As illustrated in Table 4, the moderator analysis results give a value of P = 0.00 <0.05. This means that the two study groups differed significantly. In this case, the study group that applied CTL in combination with other methods provided a greater ES.

Discussion

The first objective of this study was to examine the effect of CTL on mathematical abilities. The analysis results revealed that CTL had a high impact on mathematical abilities (ES = 0.88). This result is equivalent to that of Tamur, Jehadus, Nendi, Mandur, & Murni (2020), who reported ES 0.86 when they analyzed 21 individual studies of the effect of CTL on mathematical comprehension abilities. In addition, the results of research conducted by Tamur & Juandi (2020) also support these findings. They synthesized 33 primary studies that questioned the effects of constructivist-based learning (including CTL) and reported ES as 0.88. Although these three studies were conducted at different times, they gave the same results. This reflects the overall trend about learning that prioritizes student activity.

Further analysis was performed by examining the association between the moderator variables and the study ES. The analysis results show that CTL is associated with different combinations of learning models (P-value = 0.00 <0.05). This indicates that CTL implementation must take into account different combinations of learning, which are usually not controlled by researchers or teachers who implement them. It seems that the application of CTL in combination with other methods should be considered in the future. The reason may be related to the novelty effect (Bayraktar, 2001) that teachers who only apply CTL can cause boredom for students. On the other hand, the CTL, which is inserted with certain methods, gives a novelty and motivation effect for students.

CONCLUSION

The results reveal that CTL greatly impacts mathematical abilities by considering the combination of learning models in its application. This finding is only supported by individual studies that meet certain conditions. The random-effects model reflects that several moderating variables moderate the study's ES. In the future, it is necessary to examine several mediator variables in addition to the combination of learning models to complement the results of this study.

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REFERENCES

Arik, S., & Yilmaz, M. (2020). The effect of constructivist learning approach and active learning on environmental education: A meta-analysis study. *International Electronic Journal of Environmental Education, 10*(1), 44–84. Retrieved from https://files.eric.ed.gov/fulltext/EJ1239355.pdf

Bayraktar, S. (2001). A Meta-analysis of the Effectiveness of Computer- Assisted Instruction in Science Education. *Journal of Research on Technology in Education*, *34*(2), 173–188. https://doi.org/10.1080/15391523.2001.10782344

Borenstein, M., Hedges, L. V, Higgins, J. P. T., & Rothstein, H. R. (2009). *Introduction to Meta-Analysis*. A John Wiley and Sons, Ltd., Publication. https://doi.org/10.1002/9780470743386

Cohen, J. (1988). Statistical power analysis for the behavioral sciences. In *Department of Psychology, New York University* (Vol. 111). https://doi.org/10.1192/bjp.111.479.1009-a

Franzen, M. (2020). Meta-analysis. In H. V. Zeigler & T. . Shackelford (Eds.), *Encyclopedia of Personality and Individual Differences* (p. 5925). Springer, Cham. https://doi.org/10.1007/978-3-319-24612-3_1326

Glass, G. V. (2015). Meta-analysis at middle age: A personal history. *Research Synthesis Methods*, *6*(3), 221–231. https://doi.org/10.1002/jrsm.1133

Jehadus, E., Tamur, M., Jelatu, S., Pantaleon, K. V, Nendi, F., & Defrino, S. S. (2020). THE INFLUENCE OF CONCEPTUAL UNDERSTANDING PROCEDURES (CUPs) LEARNING MODELS CONCEPT OF UNDERSTANDING OF CONCEPT STUDENT MATH. *Journal OfEducational Experts*, *3*(2), 53–59. https://doi.org/10.30740/jee.v3i2p53-59

Juandi, D., Kusumah, Y. S., Tamur, M., Perbowo, K. S., Siagian, M. D., Sulastri, R., & Negara, H. R. P. (2021). The Effectiveness of Dynamic Geometry Software Applications in Learning Mathematics: A Meta- Analysis Study. *International Journal Interactive Mobile Technologies*, *15*(02), 18–37. https://doi.org/10.3991/ijim.v15i02.18853

Khan, S. (2020). Meta-Analysis. In S. Khan (Ed.), *Meta-Analysis* (First). Singapore: Springer Nature Singapore Pte Ltd. https://doi.org/10.1007/978-981-15-5032-4

Kistian, A., Fahreza, F., & Mulyadi, M. (2020). Perbedaan model pembelajaran contextual teaching and learning (CTL) dan ekspositori terhadap kemampuan pemecahan masalah matematis siswa di Kelas IV SDN Peunaga Cut Ujong. *HJurnal Tunas Bangsa*, *7*(1), 50–59.

Kurnila, V. S., Tamur, M., Ramda, A. H., & Parinters, A. (2018). Keefektifan permainan geometri berbasis karakter terhadap prestasi belajar dan apresiasi pada matematika. *Seminar Nasional Pendidikan Matematika*, *01*, 54–72.

Lee, Y. H. (2019). Strengths and Limitations of Meta-Analysis. *The Korean Journal of Medicine*, *94*(5), 391–395. https://doi.org/10.3904/kjm.2019.94.5.391

Mamartohiroh, S., Muhandaz, R., & Revita, R. (2020). Pengaruh Model Contextual Teaching and Learning Terhadap Kemampuan Pemecahan Masalah Matematis Berdasarkan Kemandirian Belajar Siswa SMP / MTs. *Tarbawi: Jurnal Ilmu Pendidikan*, *16*(1), 46–58.

McHugh, M. L. (2012). Lessons in biostatistics interrater reliability : the kappa statistic. *Biochemica Medica*, *22*(3), 276–282. https://doi.org/10.11613/BM.2012.031

Mullen, B., Muellerleile, P., & Bryant, B. (2001). Cumulative meta-analysis: A consideration of indicators of sufficiency and stability. *Personality and Social Psychology Bulletin*, *27*(11), 1450–1462. https://doi.org/10.1177/01461672012711006

Nurjanah, Latif, B., Yuliardi, R., & Tamur, M. (2020). Computer-assisted learning using the Cabri 3D for improving spatial ability and self- regulated learning. *Heliyon*, *6*(11), e05536. https://doi.org/10.1016/j.heliyon.2020.e05536

Paloloang, M. F. B., Juandi, D., Tamur, M., Paloloang, B., & Adem, A. M. G. (2020). META ANALISIS : PENGARUH PROBLEM-BASED LEARNING TERHADAP KEMAMPUAN LITERASI MATEMATIS SISWA DI INDONESIA TUJUH TAHUN TERAKHIR. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *9*(4), 851–864.

https://doi.org/10.24127/ajpm.v9i4.3049

Pereira, J., Huang, Y., Chen, J., Hermita, N., & Tamur, M. (2020). Learning the Concept of Absolute Value with Hawgent Dynamic Mathematics Software. *Tarbawi: Jurnal Ilmu Pendidikan*, *16*(2), 160–169. https://doi.org/10.32939/tarbawi.v16i2.688

Pigott, T. D. (2012). Advances in Meta-Analysis. In *Statistics for Social and Behavioral Sciences*. Springer New York Dordrecht Heidelberg London. https://doi.org/10.1007/978-1-4614-2278-5

Pigott, T. D., & Polanin, J. R. (2020). Methodological Guidance Paper: High-Quality Meta-Analysis in a Systematic Review. *Review of Educational Research*, *90*(1), 24–46. https://doi.org/10.3102/0034654319877153

Setiawan, R. H., & Harta, I. (2014). Pengaruh pendekatan open-ended dan pendekatan kontekstual terhadap kemampuan pemecahan masalah dan sikap siswa terhadap matematika. *Jurnal Riset Pendidikan Matematika*, *1*(2), 240–256.

Siddaway, A. P., Wood, A. M., & Hedges, L. V. (2019). How to Do a Systematic Review: A Best Practice Guide for Conducting and Reporting Narrative Reviews, Meta-Analyses, and Meta-Syntheses. *Annual Review of Psychology*, *70*(1), 747–770. https://doi.org/10.1146/annurev-psych-010418-102803

Suparman, Juandi, D., & Tamur, M. (2021). Review of problem-based learning trends in 2010-2020 : A meta-analysis study of the effect of problem-based learning in enhancing mathematical problem-solving skills of Indonesian students. *Journal of Physics: Conference Series*, *1772*(1), 012103. https://doi.org/10.1088/1742-6596/1722/1/012103

Surya, E., Putri, F. A., & Mukhtar, M. (2017). Improving mathematical problem-solving ability and self-confidence of high school students through contextual learning model. *Journal on Mathematics Education*, *8*(1), 85–94.

Susanti, N., Juandi, D., & Tamur, M. (2020). The Effect of Problem-Based Learning (PBL) Model On Mathematical Communication Skills of Junior High School Students – A Meta-Analysis Study. *JTAM (Jurnal Teori Dan Aplikasi Matematika)*, *4*(2), 145–154. https://doi.org/10.31764/jtam.v4i2.2481

Tamur, M, Jehadus, E., Nendi, F., Mandur, K., & Murni, V. (2020). Assessing the effectiveness of the contextual teaching and learning model on students ' mathematical understanding ability : a meta-analysis study. *Journal of Physics: Conference Series*, *1657*(1), 012067. https://doi.org/10.1088/1742-6596/1657/1/012067

Tamur, M, & Juandi, D. (2020). Effectiveness of Constructivism Based Learning Models Against Students Mathematical Creative Thinking Abilities in Indonesia: A Meta-Analysis Study. *Pervasive Health: Pervasive Computing Technologies for Healthcare*, (1), 107–114. https://doi.org/10.4108/eai.12-10-2019.2296507

Tamur, Maximus. (2012). *Pembelajaran Kooperatif Tipe STAD Berbasis Etnomatematika Sebagai Upaya Meningkatkan Kemampuan Pemahaman Dan Komunikasi Matematis Mahasiswa PGSD: Mengintegrasikan Tarian Caci Ke Dalam Bahan Ajar Di STKIP St Paulus Ruteng-Flores NTT* (Universitas Pendidikan Indonesia). Universitas Pendidikan Indonesia. Retrieved from http://repository.upi.edu/7778/2/t_mtk_1007346

Tamur, Maximus, Jehadus, E., Negara, H. R. P., Siagian, M. D., Marzuki, M., & Sulastri, R. (2021). Pembelajaran Selama Krisis COVID - 19 : Meta - Analisis dari Sudut Hasil Belajar yang Diukur. *Jurnal Riset Teknologi Dan Inovasi Pendidikan (JARTIKA)*, *4*(1), 101–108. https://doi.org/10.36765/jartika.v4i1.413

Tamur, Maximus, & Juandi, D. (2020). Effectiveness of Constructivism Based Learning Models Against Students Mathematical Creative Thinking Abilities in Indonesia: A Meta-Analysis Study. *Mathematics, Science, and Computer Science Education International Seminar, MSCEIS 2019*, 1–8. Bandung, Indonesia: EAI. https://doi.org/10.4108/eai.12-10-2019.2296507

Tamur, Maximus, Juandi, D., & Adem, A. M. G. (2020). Realistic Mathematics Education in Indonesia and Recommendations for Future Implementation : A Meta-Analysis Study. *Jurnal Teori Dan Aplikasi Matematika*, *4*(1), 17–27. https://doi.org/10.31764/jtam.v4i1.1786

Tamur, Maximus, Juandi, D., & Kusumah, Y. S. (2020). The Effectiveness of the Application of Mathematical Software in Indonesia: A Meta-Analysis Study. *International Journal of Instruction*, *13*(4), 867–884. https://doi.org/10.29333/iji.2020.13453a

Yunita, Y., Juandi, D., Tamur, M., Adem, A. M. G., & Pereira, J. (2020). A meta-analysis of the effects of problem-based learning on students ' creative thinking in mathematics. *Beta: Jurnal Tadris Matematika*, *13*(229), 104–116. https://doi.org/10.20414/betajtm.v13i2.380