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Effect Size of STEM-Based Problem Based Learning Model on Problem Solving Ability in Students

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Abstrak

Penelitian ini bertujuan untuk mengetahui efek size model problem based learning berbasis STEM Terhadap kemampuan pemecahan masalah siswa. Jenis penelitian ini adalah meta-analisis. Sumber data berasal 14 jurnal nasional dan internasional. Proses pencarian sumber dalam penelitian melalui Google scholar. Eric dan ScienceDirect. Teknik pengumpulan data adalah observasi langsung dan dokumentasi menelusuri database jurnal. Analisis data adalah analisis statistik kuantitatif dengan bantuan aplikasi Comprehensive Meta-Analysis (CMA) veris 3.0. Hasil penelitian menunjukan bahwa nilai rata effect size sebesar 0.912 kriteria tinggi. Temuan ini menunjukan terdapat pengaruh yang signifikan model problem based learning berbasis STEM terhadap kemampuan pemecahan masalah pada siswa. Model problem based learning membantu siswa berpikir tingkat tinggi dalam belajar.

Kata Kunci: Effect Size, Model Problem Based Learning, STEM, Pemecahan Masalah

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Abstract

This study aims to determine the effect size of the STEM-based problem-based learning model on students' problem-solving skills. This type of research is a meta-analysis. Data sources come from 14 national and international journals. The process of finding sources in research through Google Scholar. Eric and ScienceDirect. Data collection techniques are direct observation and documentation tracing the journal database. Data analysis is quantitative statistical analysis with the help of the Comprehensive Meta-Analysis (CMA) veris 3.0 application. The results showed that the average effect size value of 0.912 was high. This finding shows that there is a significant effect of the STEM-based problem-based learning model on students' problem-solving skills. The problem-based learning model helps students think at a higher level in learning.

***Keywords**: Effect Size, Problem-Based Learning Model, STEM, Problem Solving*

Introduction

Problem solving is an ability that students must have in facing the industrial revolution 4.0 (Nurtamam et al., 2023; Kadir et al., 2016; Rahman et al., 2023; Suryono et al., 2023; Seyhan, 2016). Problem solving skills help students in providing solutions in learning (Suana & Raviany, 2019; Ichsan et al., 2023; Oktarina et al., 2021). Students who have solving skills will better understand the material and concepts of the lesson (Çetİn, 2023; Sari et al., 2021; Valdez & Bungihan, 2019; Supriyadi et al., 2023; Novilia et al., 2022). Not only that, problem solving abilities encourage students to develop their abilities in learning (Payadnya & Jayantika, 2021). Karan & Brown (2022) students who have problem solving abilities are more active and creative in learning so that they are able to provide ideas in solving a problem in learning.

The ability of problem solving in students is still low (Hikmasari et al., 2020; Rahmawati, 2019; Sandi, 2012; Suharyat et al., 2022). This can be the result of the 2015 Trends in International Mathematics and Science Study (TIMSS) research, the level of problem-solving thinking skills of students in Indonesia is still below international standards of 501 (Zulyusri et al., 2023; Palera et al., 2020). Furthermore, the results of the 2015 Program For International Student Assessment (PISA) survey of Indonesian students' scientific literacy in problem solving obtained a score of 383, ranking 65th out of 68 member countries (Kurniawati & Hidayah, 2021). PISA results for 2018 scientific literacy of Indonesian students obtained a score of 396 ranking 71 out of 78 countries (Elfira et al., 2023; Ichsan et al., 2022; Sofianora et al., 2023; Putra et al., 2023; Salsabila & Maarif, 2022). Research result Aritonang & Safitri (2021) low level of problem solving and students' scientific literacy in learning influenced by 98% of students have low learning understanding. Students have not been able to complete the questions based on problem solving abilities (Nur & Amal, 2022). Research result (Saragih et al., 2022) shows the low ability of problem solving in students due to the use of inappropriate learning models and methods.

The Problem Based Learning Model is a learning model that guides students in solving problems in learning (Wulandari & Suryono, 2013; Rahman & Ristiana, 2020; Suharyat et al., 2022; Bagus et al., 2022; Zamir et al., 2022). The problem-based learning model is effective in improving students' problem-solving abilities (Wahyuni & Fauzan, 2021). The problem based learning model makes students more active and creative in learning so as to stimulate their problem solving skills (Saputri & Wardani, 2021). Widyastuti & Airlanda (2021) Problem based learning models can improve problem solving abilities in teaching and learning activities. Furthermore, the problem-based learning model based on Science Technology Engineering and Mathematics (STEM) helps students master science and technology which can help students solve problems (Hanifah & Indarini, 2021; Arifin, 2020; Mustofa et al., 2021). Learning based on science and technology makes it easy for students to access information and learning materials (Tubagus et al., 2019; Tubagus & Muslim, 2020; Santosa et al., 2021; Suharyat et al., 2022). STEM learning helps students to be more

innovative and creative in learning (Hadi, 2021; Dede, 2022; Deák et al., 2021).

STEM learning helps students to be more innovative and creative in learning (Priatna et al., 2022) shows that the STEM-based Problem Based Learning learning model can improve students' problem-solving skills in triogeometric material. Research by Riyanti (2020) STEM-based problem-based learning models have an influence on students' creative thinking skills. In addition, the STEM-based problem-based learning model is very effective in improving students' problem-solving skills(Aini et al., 2022). In fact, there is still little research that describes how much influence the STEM-based Problem-Based Learning model has on students' problem-solving abilities. Based on these problems, this study aims to determine the effect of STEM-based problem-based learning model size on students' problem-solving abilities.

Methods

This research is a kind of meta-analysis research. Meta-analytic research is a type of research that analyzes previous studies that can be analyzed statistically (Razak et al.., 2021; Musna et al., 2021; Suharyat et al., 2022; Rahman , et al., 2023; Suhaimi et al., 2022; Suparman et al., 2021; Ichsan et al., 2022; Balakrishnan et al., 2021). The data sources in this study came from 14 national and international journals. Search for data sources through google scholar, Eric and ScienceDirect. Data collection techniques in the study were direct observation and documentation through the journal database. The meta-analysis steps in this study are 1) problem formulation; 2) data collection; 3) data coding; and 4) data analysis and interpretation. (Ranggi et al., 2021). The data analysis technique used is quantitative statistical analysis with the help of the Comprenhensive Meta-Analysis (CMA) version 3.0 application. Data analysis calculates the Effect Size value, Standard deviation, Standard Error and the average value of each study. The formula used to calculate the effect size value is:

$$ES = \frac{X_{Post} - X_{Pre}}{SD_{Pre}}$$

Atau

$$ES = \frac{X_E - X_E}{SD_c}$$

Atau

Atau

$$ES = \left(\frac{(X_{post} - X_{pre})\ E - \left(X_{Post} - X_{pre}\right)C}{\frac{(SD_{pre\ C} - SD_{post\ E} + SD_{Post\ C}}{3}}\right.$$

Atau

$$ES = t\sqrt{\frac{1}{n_E} + \frac{1}{n_c}}$$

Description:

ES : Effect Size

X_{post} : average posttest score

X_{Pre} : average pretest score

SD_{pre} : Standard Deviation pretest

X_E : experimental group average

X_C : control group average

t : t value

N_E : Number of experimental class samples

N_C : Number of control class samples

Furthermore, the criteria for calculating the effect size value of each data source analyzed can be seen in Table 1.

Table 1. Effect Size Criteria

Effect Size	Kriteria *Effect Size*
0 ≤ ES ≤ 0.2	Low
0.2 ≤ ES ≤ 0.8	Medium
ES ≥ 0.8	High

Source: Cohen dalam Nastiti et al., 2021;Santosa et al., 2021; Karim et al., 2023)

Restult and Discussion

Result

From the results of the analysis of 14 national and international journals on the effect of the STEM-based problem-based learning model on students' problem solving skills, the effect size value is calculated, which can be seen in Table 2.

Table 2. Effect Size of Each Data Source

Journal Code	Year	Journal Type	Effect Size	Criteria
C1	2018	National	1.18	Medium
C2	2018	National	0.78	Medium
C3	2023	International	0.81	High
C4	2022	International	0.96	High
C5	2020	National	1.26	High
C6	2019	National	1.16	High
C7	2021	National	0.89	High
C8	2023	International	0.30	Small
C9	2022	National	0.77	Medium
C10	2021	National	1.65	High
C11	2019	International	0.82	High
C12	2020	National	0.76	Medium
C13	2023	National	0.60	Medium
C14	2023	National	0.84	Medium
Average Effect Size value			**0.912**	**Hight**

The average effect size value (ES = 0.912) with high criteria. The results explain that the STEM-based problem-based learning model has a significant effect on students' problem solving skills compared to conventional learning. Furthermore, analyzing the effect size based on the level of education that applies the STEM-based problem-based learning model in schools can be seen in Table 3.

Table 3. Effect Size Calculation Results Based on Level of Education

Education Level	Journal Code	Effect Size	Average/level	Overall mean	Criteria
SD	C1	1.18	**0.920**		
	C2	0.78			
	C3	0.81			
SMP	C4	0.96	**1.06**		
	C5	1.26			
	C6	1.16			
	C7	0.89			
SMA	C8	0.30	**0.956**	**0.978**	**High**
	C9	0.77			
	C10	1.65			
	C11	0.82			
	C12	0.76			
	C13	0.60			
	C14	0.84			

Based on Table 3. The average value of elementary school education level is 0.920 with high criteria, junior high school education level is 1.06 with high criteria and high school education level is 0.956 with high criteria. Furthermore, the overall average value of education level is 0.978 with high criteria. These results explain that the application of STEM-based problem-based learning model has a high impact on problem solving skills at the elementary to high school education level. So, the application of STEM-based problem-based learning model has a positive impact on students' learning potential at school.

Next, conduct hypothesis testing to see the effectiveness of the STEM-based problem-based learning model on students' problem solving skills by using the random effect model. The results of the random effect model test can be seen in Table. 4.

Table 4. Hypothesis Test with Random Effect Model

Estimation Model	n	P	Effect Size	Standard Error
Random Effect Model	14	0.000	0.912	0.425

Based on Table 4. Showing the p-value <0.05 with an effect size value of 0.912, it can be concluded that the problem-based learning model based on Science Technology Engineering and Mathamatics (STEM) effectively encourages students' problem solving skills. Therefore, the problem-based learning model is highly recommended to be implemented in schools in Indonesia.

Discussion

The application of the Science Technology Engineering and Mathamatics (STEM) based problem-based learning model has a positive effect on students' problem solving skills. This can be seen from the average effect size value (ES = 0.912) with high criteria. Research results Astuti et al., (2021) STEM-based problem-based learning model encourages students to be more active and innovative in learning so as to encourage their problem-solving skills. The problem-based learning model is able to challenge students to solve a problem in learning (Yusri et al., 2018; Sudarsono et al., 2022; Sahin, 2021; Ichsan et al. , 2023). Not only that, the problem-based learning model based on Science Technology Engineering and Mathamatics (STEM) encourages students' ability to access information that can be used as learning resources. (Putri et al., 2019; Martaningsih et al., 2022; Nurfitriyanti, 2016;Tubagus, 2023). Not only that, the STEM-based problem-based learning model affects students' educational level in encouraging problem-solving skills.

Science Technology Engineering and Mathamatics (STEM)-based problem-based learning gave junior high school students higher performance in problem solving ability. Table 3. Explains the average value of STEM-based problem-based learning for junior high school students of 1.06 higher than elementary and high school students. The result of the research Ionita (2020) The level of education affects students' problem-solving skills. Not only that, the level of education greatly influences the learning process that encourages students' problem-solving skills (Zamir et al.,2022; Zhang et al., 2015; Utomo et al., 2014). Furthermore, problem-solving skills help students more easily understand learning materials and concepts. (Sumiantari et al., 2019). So, the STEM-based problem-based learning model makes it easier for students to access knowledge that stimulates their problem-solving skills in life. (Fradila et al., 2021; Safithri & Huda, 2021; Yustiana el al., 2022).

Next Pekbay (2022) STEM-based problem-based learning model increases students' problem solving ability and creativity in learning. STEM learning helps students to combine science, technology, engineering and mathematics in life that can provide solutions in problem solving (Muzana et al., 2021; Kartini et al., 2021). STEM-based problem-based learning model makes it easier for students to master learning technology that serves to gain knowledge for the learning process (Adaylarının et al., 2021; Rahman et al., 2023). Knowledge is everything that is obtained from various sources that encourage students to get information

(Ferry et al., 2019). Therefore, the STEM-based problem-based learning model is one of the solutions to improve the quality of students' thinking potential in learning.

Conclusion

From this study it can be concluded that the average effect size value of 0.912 is high. This finding shows that there is a significant effect of STEM-based problem-based learning model on students' problem solving skills. The problem-based learning model helps students think at a higher level in learning. Furthermore, the problem-based learning model is effective to help the learning process of school students in improving students' thinking skills. STEM-based problem-based learning model helps teachers to be more creative in conducting the learning process.

Reference

Adnan& B. W. D. S. (2013). Pengaruh Problem-Based Learning Terhadap Hasil Belajar The Effect Of Problem-Based Learning On The Learning Outcomes Seen From Motivation On The Subject Matter. *Jurnal Pendidikan Vokas*, *3*(2), 178–191.

Adaylarının, Ö., Çözme, P., & Etki, B. (2021). The Investigation of the Effect of Montessori Approach-based STEM Activities on the Problem-solving Skills of Pre-service Preschool Montessori Yaklaşım Temelli STEM Etkinliklerinin Okul Öncesi Today , economic developments and technological changes have c. *Journal of Theoretical Educational Science*, *14*(April), 93–119.

Aini, M., Ridianingsih, D. S., & Yunitasari, I. (2022). EFEKTIVITAS MODEL PEMBELAJARAN PROJECT BASED LEARNING (PjBL) BERBASIS STEM TERHADAP KETERAMPILAN BERPIKIR KRITIS SISWA THE EFFECTIVENESS OF STEM-BASED PROJECT BASED LEARNING (PjBL) LEARNING MODEL ON CRITICAL THINKING. *Jurnal Kiprah Pendidikan*, *1*(4), 247–253.

Arifin, N. (2020). EFEKTIVITAS PEMBELAJARAN STEM PROBLEM BASED LEARNING DITINJAU DARI DAYA JUANG DAN KEMAMPUAN PEMECAHAN. *Jurnal Pendidikan Matematika Indonesia*, *5*(1), 31–38.

Aritonang, I., & Safitri, I. (2021). Pengaruh Blended Learning Terhadap Peningkatan Literasi Matematika Siswa. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *5*(1), 735–743. https://doi.org/10.31004/cendekia.v5i1.555

Astuti, N. H., Rusilowati, A., & Subali, B. (2021). Journal of Innovative Science Education STEM- Based Learning Analysis to Improve Students ' Problem Solving Abilities in Science Subject : a Literature Review. *Journal of Innovative Science Education*, *10*(19), 79–86.

Bagus, I., Putra, A., Id, M., & Id, C. W. (2022). The effectiveness of problem based learning in improving critical thinking , problem-solving and self-directed learning in first-year medical students : A meta-analysis. *PLos ONE*, *17*(11), 1–12. https://doi.org/10.1371/journal.pone.0277339

Balakrishnan, A., Puthean, S., Satheesh, G., Unnikrishnan, M. K., Rashid, M., Nair, S., & Id, G. T. (2021). Effectiveness of blended learning in pharmacy education : A systematic review and meta- analysis. *PLos ONE*, *16*(6), 1–17. https://doi.org/10.1371/journal.pone.0252461

Çetİn, İ. (2023). The Effect of Gamified Adaptive Intelligent Tutoring System Artibos on Problem-Solving Skills Ali

Kürşat ERÜMİT Vasif NABİYEV Hasan KARAL Computer Education of Instructional Technology Department of Trabzon University / Türkiye Temel KÖSA Mehmet KOKOÇ. *Participatory Educational Research (PER*, *10*(1), 344–374.

Csaba Deák 1, 2,*, B. K. 3, & , István Szabó 4, G. N. 5 and S. S. (2021). education sciences Evolution of New Approaches in Pedagogy and STEM with. *Educ. Sci*, *19*, 1–16.

Dede, H. (2022). Evaluation of STEM SOS Model : Pre-Service Science Teachers ' Opinions. *International Journal of Progressive Education*, *18*(3), 0–2. https://doi.org/10.29329/ijpe.2022.439.4

Dharma Ferry1*, Tomi Apra Santosa2, D. K. (2019). Pengetahuan Mahasiswa Institut Agama Islam Negeri Kerinci Tentang Teori Asal Usul Manusia Dharma. *Bioeduca: Journal of Biology Education*, *1*(1), 12–17.

Elfira, I., & Santosa, T. A. (2023). Literature Study : Utilization of the PjBL Model in Science Education to Improve Creativity and Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 133–143. https://doi.org/10.29303/jppipa.v9i1.2555

Fradila, E., Razak, A., Santosa, T. A., Arsih, F., & Chatri, M. (2021). Development Of E-Module-Based Problem Based Learning (PBL) Applications Using Sigil The Course Ecology And Environmental Education Students Master Of Biology. *International Journal of Progressive Sciences and Technologies (IJPSAT)*, *27*(2), 673–682.

Hadi, F. R. (2021). Efektifitas Model Pbl Terintegrasi STEM Terhadap Kemampuan Berpikir Kritis Matematis Siswa Kelas V SD. *Jurnal Pendidikan Tambusai*, *5*(3), 6644–6649.

Hanifah, M., & Indarini, E. (2021). Efektivitas Model Pembelajaran Discovery Learning dengan Model Problem Based Learning terhadap Kemampuan Pemecahan Masalah Siswa di Sekolah Dasar. *JURNAL BASICEDU*, *5*(4), 2571–2584.

Hikmasari, P., Asih, T. S. N., & Prabowo, A. (2020). Bagaimanakah Audience Feedback Mempengaruhi Peningkatan Kemampuan Pemecahan Masalah? Studi dalam PBL dengan Lingkungan Blended Learning. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *11*(2), 194–203. https://doi.org/10.15294/kreano.v11i2.26211

Ichsan, Tomi Apra Santosa, Ilwandri, Aulia Sofianora, U. Y. (2022). Efektivitas Evaluasi Model CIPP Dalam Pembelajaran IPA di Indonesia : Meta-Analisis. *Jurnal Pendidikan Dan Konseling*, *5*(2), 1349–1358.

Ichsan, Yayat Suharyat, Tomi Apra Santosa, E. (2023). The Effectiveness of STEM-Based Learning in Teaching 21 st Century Skills in Generation Z Student in Science Learning : A. *Jurnal Penelitian Pendidikan IPA*, *9*(1), 150–166. https://doi.org/10.29303/jppipa.v9i1.2517

Ichsan et al. (2022). Pengaruh Model Pembelajaran Problem Based Learning Berbaisis TPACK Terhadap Ketrampilan Literasi Sains Dalam Pembelajaran IPA Siswa Tingkat SD Sampai SMA: Sebuah Meta-Analisis. *Jurnal Pendidikan Dan Konseling*, *4*, 2173–2181.

Ionita, F. (2020). PENGARUH MODEL PROBLEM BASED LEARNING TERHADAP KEMAMPUAN PEMECAHAN MASALAH MATERI PENCEMARAN LINGKUNGAN SISWA SMA NEGERI 13 MEDAN. *JURNAL BIOLOKUS*, *3*(1), 245–251.

Kadir, Z. A., Abdullah, N. H., Anthony, E., Salleh, B. M., & Kamarulzaman, R. (2016). Does Problem-Based Learning Improve Problem Solving Skills?—A

Study among Business Undergraduates at Malaysian Premier Technical University. *International Education Studies*, *9*(5), 166. https://doi.org/10.5539/ies.v9n5p166

Karan, E., & Brown, L. (2022). Enhancing Student's Problem-solving Skills through Project-based Learning. *Journal of Problem Based Learning in Higher Education*, *10*(1), 74–87. https://doi.org/10.54337/ojs.jpblhe.v10i1.6887

Kartini, F. S., Widodo, A., Winarno, N., & Astuti, L. (2021). *Promoting Student ' s Problem - Solving Skills through STEM Project - Based Learning in Earth Layer and Disasters Topic*. *4*(August 2020). https://doi.org/10.17509/jsl.v4i3.27555

Kurniawati, K., & Hidayah, N. (2021). Pengaruh Pembelajaran Problem Based Learning Berbasis Blended Learning terhadap Kemampuan Literasi Sains. *Bioedusiana: Jurnal Pendidikan Biologi*, *6*(2), 184–191. https://doi.org/10.37058/bioed.v6i2.3090

Luvia Ranggi, N., Yokhebed, Ramli, M., & Yuliani, H. (2021). Meta-Analysis of the Effectiveness of Problem-Based Learning towards Critical Thinking Skills in Science Learning. *Journal of Physics: Conference Series*, *1842*(1), 1–10. https://doi.org/10.1088/1742-6596/1842/1/012071

M. Karim , Syafrul Antoni2, Karlini Oktarina3, T. A. S. (2023). The Effect of Teacher Professionalism in Islamic Religious Education in the Era of Society 5.0 in Indonesia: A Meta-Analysis. *Jurnal Pendidikan Dan Konseling*, *5*(2), 1349–1358.

Musna et al. (2021). A meta-analysis study of the effect of Problem- Based Learning model on students ' mathematical problem solving skills A meta-analysis study of the effect of Problem-Based Learning model on students ' mathematical problem solving skills. *Journal of Physics: Conference Series*, *1882*, 1–8. https://doi.org/10.1088/1742-6596/1882/1/012090

Mustofa et al. (2021). Efektivitas Model Pembelajaran Problem Based Learning Berbasis STEM Terhadap Peningkatan Kemampuan Berpikir Kritis Sisw. *Jurnal Tadris IPA Indonesia*, *1*(3), 375–384.

Muzana, S. R., Wilujeng, I., Yanto, B. E., & Mustamin, A. A. (2021). E-STEM project-based learning in teaching science to increase ICT literacy and problem solving. *International Journal of Evaluation and Research in Education (IJERE)*, *10*(4), 1386–1394. https://doi.org/10.11591/ijere.v10i4.21942

Net, W. W. W. P., Martaningsih, S. T., Maryani, I., Prasetya, D. S., Prwanti, S., Sayekti, I. C., & Aziz, N. A. A. (2022). Stem Problem-Based Learning Module : A Solution to Overcome Elementary Students ' Poor Problem-Solving Skills. *Pegem Journal of Education and Instruction*, *12*(4), 340–348. https://doi.org/10.47750/pegegog.12.04.35

Noni Riyanti Saragih 1, Suprapto Manurung2, Y. O. P. (2022). Pengaruh Model Pembelajaran Blended Learning menggunakan Google Classroom terhadap Kemampuan Pemecahan Masalah Matematis Siswa. *Jurnal Pendidikan Dan Konseling*, *4*(6), 1248–1259.

Novilia, R., Rinaldi, A., & Andriani, S. (2022). Blended learning models dengan pendekatan TPACK berbantuan e-learning: dampaknya terhadap kemampuan pemecahan masalah matematis. *Edu Sains: Jurnal Pendidikan Sains Dan Matematika*, *10*(2), 155.

Nur, A. M., & Amal, A. (2022). Blended

Learning: Penerapan dan Pengaruhnya Terhadap Kemampuan Berpikir Kritis Mahasiswa Program Studi PGSD. *JURNALBASICEDU*, *6*(1), 1263–1276.

NURFITRIYANTi, M. (2016). MODEL PEMBELAJARAN PROJECT BASED LEARNING TERHADAP KEMAMPUAN PEMECAHAN MASALAH. *Jurnal Formatif*, *6*(2), 149–160.

Nurtamam, M. E., Santosa, T. A., Aprilisia, S., Rahman, A., & Suharyat, Y. (2023). Meta-analysis : The Effectiveness of Iot-Based Flipped Learning to Improve Students ' Problem Solving Abilities. *Edumaspul :Jurnal Pendidikan*, *7*(1), 1491–1501.

Oktarina, K., Suhaimi, S., Santosa, T. A., & ... (2021). Meta-Analysis: The Effectiveness of Using Blended Learning on Multiple Intelligences and Student Character Education During the Covid-19 Period. *… Journal of Education …*, *4*(3), 184–192. http://journal.ummat.ac.id/index.php/IJECA/article/view/5505%0Ahttps://journal.ummat.ac.id/index.php/IJECA/article/download/5505/pdf

Palera, V., Anriani, N., & FS, C. A. H. (2020). Pengaruh Model Blended Learning Berbantuan Video Interaktif Terhadap Kemampuan Pemecahan Masalah Matematis Siswa. *ALGORITMA: Journal of Mathematics Education*, *1*(2), 103–116. https://doi.org/10.15408/ajme.v1i2.14072

Payadnya, I. P. A. A., & Jayantika, I. G. A. N. T. (2021). Penerapan Model Pembelajaran Blended Learning Untuk Meningkatkan Kemampuan Pemecahan Masalah Pada Mata Kuliah Metode Statistika Ii. *Jurnal Santiaji Pendidikan*, *11*(2), 134–143. http://e-journal.unmas.ac.id/index.php/jsp/article/view/2444

Pekbay, C. (2022). An Analysis on the Effect of Design-Based STEM Activity Development Process on Prospective Maths Teachers ' Problem-Solving Skills and Scientific Creativity. *ELECTRONIC JOURNAL FOR RESEARCH IN SCIENCE & MATHEMATICS EDUCATION*, *26*(4), 84–110.

Priatna, N., Avip, B., Mulyati, R., & Sari, M. (2022). Efektifitas Project Based Learning-STEM dan Pemecahan MasalahMatematis Siswa pada Materi Trigonometri. *SJME (Supremum Journal of Mathematics Education)*, *6*(2), 151–161. https://doi.org/10.35706/sjme.v6i2.6588

Putra, M., Rahman, A., Suhayat, Y., Santosa, T. A., & Putra, R. (2023). The Effect of STEM-Based REACT Model on Students ' Critical Thinking Skills : A Meta-Analysis Study. *LITERACY : International Scientific Journals Of Social, Education and Humaniora*, *2*(1), 207–217.

Putri, R. S., Suryani, M., & Jufri, H. (2019). Pengaruh Penerapan Model Problem Based Learning terhadap Kemampuan Pemecahan Masalah Matematika Siswa Mosharafa : Jurnal Pendidikan Matematika dan Program for International Student Mosharafa : Jurnal Pendidikan Matematika. *Mosharafa: Jurnal Pendidikan Matematika*, *8*(2), 331–340.

Rahman, A., Islam, P. A., Bekasi, U. I., Ipa, P., Padang, U. N., Jambi, U., Pendidikan, M., Islam, A., Uin, F., & Bonjol, I. (2023). *Meta-Analisis : Pengaruh Pendekatan STEM berbasis Etnosains Terhadap Kemampuan Pemecahan Masalah dan Berpikir Kreatif Siswa*. *3*, 2111–2125.

Rahman, A., & Ristiana, E. (2020). Pengaruh Model PBL Terhadap Kemampuan Berpikir Kritis dan Pemahaman Konsep IPA Siswa Kelas V SDN 30 Sumpangbita. *Edumaspul: Jurnal Pendidikan*, *4*(1), 29–41.

Rahman, A., Santosa, T. A., & Suharyat, Y. (2023). *The Effect of Problem Based*

Learning-STEM on Students ' 21st Century Skills in Indonesia : A Meta-Analysis. *2*(1).

Rahmawati, R. (2019). Penerapan Metode Mind Mapping Berbantuan Edmodo Blended Learning Untuk Meningkatkan Kemampuan Pemecahan Masalah Matematis. *Indiktika : Jurnal Inovasi Pendidikan Matematika*, *1*(1), 44–54. https://doi.org/10.31851/indiktika.v1i1.2830

Razak, Abdul, Santosa, Tomi Apra, Lufri., et al. (2021). Meta-Analisis: Pengaruh Soal HOTS (Higher Order Thinking Skill) Terhadap Kemampuan Literasi Sains dan Lesson Study Siswa Pada Materi Ekologi dan Lingkungan Pada Masa Pandemi Covid-19. *Bioedusiana*, *6*(1), 79–87.

Riski Tri Widyastuti1?, G. S. A. (2021). Efektivitas Model Problem Based Learning terhadap Kemampuan Pemecahan Masalah Matematika Siswa Sekolah Dasar. *JURNAL BASICEDU*, *5*(3), 1120–1129.

Riyanti. (2020). Efektivitas Penggunaan Perangkat Pembelajaran Project Based Learning (PjBL) Terintegrasi STEM Berbasis E-Learning Untuk meningkatkan Kemampuan Berpikir Kreatif. *DWIJA CENDEKIA :Jurnal Riset Pedagogik*, *4*(2), 206–215.

Safithri, R., & Huda, N. (2021). Pengaruh Penerapan Problem Based Learning (PBL) dan Project Based Learning (PjBL) Terhadap Kemampuan Pemecahan Masalah Berdasarkan Self Efficacy Siswa. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *05*(01), 335–346.

ŞAHİN, H. (2021). THE EFFECT OF STEM-BASED EDUCATION PROGRAM ON PROBLEM SOLVING SKILLS OF FIVE YEAR OLD. *Malaysian Online Journal of Educational Technology*, *9*(4), 69–88.

Salsabila, & Maarif, S. (2022). Efektivitas Model Blended Learning Berbasis Learning Managaments System Terhadap Kemampuan Literasi. *Jurnal Cakrawala Pendas*, *8*(4), 1208–1219.

Samina ZamirID, Zhang Yang*, Hao Wenwu, U. S. (2022). Assessing the attitude and problem-based learning in mathematics through PLS-SEM modeling. *PLos ONE*, *17*(5), 1–15. https://doi.org/10.1371/journal.pone.0266363

Sandi, G. (2005). Pengaruh Blended Learning Terhadap Hasil Belajar Kimia Ditinjau Dari Kemandirian Siswa. *Jurnal Pendidikan Dan Pengajaran*, 241–251.

Santosa, T. A., Razak, A., Arsih, F., & Sepriyani, E. M. (2021). Meta-Analysis : Science Learning Based on Local Wisdom Against Preserving School Environments During the Covid-19 Pandemic. *Journal of Biology Education*, *10*(2), 244–251.

Santosa, T. A., Sepriyani, E. M., & Razak, A. (2021). Analisis E-Learning Dalam Pembelajaran Evolusi Mahasiswa Pendidikan Biologi Selama Pandemi Covid-19. *Jurnal Edumaspul*, *5*(1), 66–70.

Saputri, Y., & Wardani, K. W. (2021). Meta Analisis : Efektivitas Model Pembelajaran Problem Solving dan Problem Based Learning Ditinjau Dari Kemampuan Pemecahan Masalah Matematika SD. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *05*(2), 935–948.

Sari, Y. I. (2021). The Effect of Problem Based Learning on Problem Solving and Scientific Writing Skills. *International Journal of Instruction*, *14*(2), 11–26.

Seyhan, H. G. (2016). The Efficacy of Problem-Based Learning in an Instrumental Analyse Laboratory. *Higher Education Studies*, *6*(4), 100. https://doi.org/10.5539/hes.v6n4p100

Sofianora, A., Suharyat, Y., & Santosa, T. A. (2023). *PENGARUH PROFESIONALITAS GURU MATEMATIKA DALAM*

MENINGKATKAN KOMPETENSI SISWA ERA REVOLUSI INDUSTRI 5 . 0 DI INDONESIA : SEBUAH META-ANALISIS. *10*(2).

Suana, W., & Raviany, M. (2019). BLENDED LEARNING BERBANTUAN WHATSAPP : PENGARUHNYA TERHADAP KEMAMPUAN BERPIKIR KRITIS DAN KEMAMPUAN PEMECAHAN MASALAH. *GRAVITY*, *5*(2), 37–45.

Sudarsono, Kartono, Mulyono, & Mariani, S. (2022). The Effect of STEM Model Based on Bima's Local Cultural on Problem Solving Ability. *International Journal of Instruction*, *15*(2), 83–96. https://doi.org/10.29333/iji.2022.1525a

Suhaimi, Santosa, T. A., & Aprilisia, S. (2022). Analisis Pendekatan Saintifik Dalam Pembelajaran IPA Selama Pandemi Covid-19 di Sekolah Dasar. *Jurnal Didika: Wahana Ilmiah Pendidikan Dasar*, *8*(1), 92–101.

Suharyat, Y., Ichsan, Satria, E., Santosa, T. A., & Amalia, K. N. (2022). Meta-Analisis Penerapan Model Pembelajaran Problem Based Learning Untuk Meningkatkan Ketrampilan Abad-21 Siswa Dalam Pembelajaran IPA. *Jurnal Pendidikan Dan Konseling*, *4*(5), 5081–5088.

Suharyat, Y., Santosa, T. A., Yulianti, S., & Amalia, K. N. (2022). *International Journal of Education and Literature (IJEL) Literature Review : TPACK-Based Science Learning in Supporting Teacher Quality in Indonesia*. 2014–2020.

Sumiantari, N. L. E., Suardana, I. N., & Selamet, K. (2019). PENGARUH MODEL PROBLEM BASED LEARNING TERHADAP KEMAMPUAN PEMECAHAN MASALAH IPA SISWA KELAS VIII SMP Universitas Pendidikan Ganesha. *JPPSI: Jurnal Pendidikan Dan Pembelajaran Sains Indonesia*, *2*(April), 12–22.

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*, *1722*(1). https://doi.org/10.1088/1742-6596/1722/1/012103

Supriyadi, A., Suharyat, Y., Santosa, T. A., & Sofianora, A. (2023). The Effectiveness of STEM-Integrated Blended Learning on Indonesia Student Scientific Literacy : A Meta-analysis. *International Journal of Education and Literature (IJEL)*, *2*(1), 41–48.

Suryono, W., Haryanto, B. B., Santosa, T. A., Suharyat, Y., & Sappaile, B. I. (2023). The Effect of The Blended Learning Model on Student Critical Thinking Skill : Meta-analysis. *Edumaspul - Jurnal Pendidikan*, *7*(1), 1386–1397.

Tubagus, M. (2023). Hybrid Learning Approach Using Chamilo for Students of the Faculty of Tarbiyah dan Ilmu Keguruan , Institut Agama Islam Negeri (IAIN) Manado. *QALAMUNA: Jurnal Pendidikan, Sosial, Dan Agama*, *15*(2), 505–514. https://doi.org/10.37680/qalamuna.v15i2.2653

Tubagus, M., & Muslim, S. (2020). Development of Learning Management System-Based Blended Learning Model using Claroline in Higher Education. *IJIM*, *14*(6), 186–194.

Tubagus, M., Muslim, S., & . S. (2019). The Impact of The Development of Blended Learning Models Using Computer applications in Higher Education. *International Journal of Educational Research Review*, *4*(4), 573–581. https://doi.org/10.24331/ijere.628410

Utomo, T., Wahyuni, D., Hariyadi, S., Studi, P., Biologi, P., Keguruan, F., & Unej, U. J. (2014). Pengaruh Model Pembelajaran Berbasis Masalah (Problem Based Learning) Terhadap Pemahaman

Konsep dan Kemampuan Berpikir Kreatif Siswa (Siswa Kelas VIII Semester Gasal SMPN 1 Sumbermalang Kabupaten Situbondo Tahun Ajaran 2012 / 2013) (The Effect of Pro. *JURNAL EDUKASI UNEJ*, *7*(1), 5–9.

Valdez, J. E., & Bungihan, M. E. (2019). Problem-based learning approach enhances the problem solving skills in chemistry of high school students. *Journal of Technology and Science Education*, *9*(3), 282–294. https://doi.org/10.3926/JOTSE.631

Wahyuni, P., & Fauzan, A. (2021). PENGARUH PROBLEM BASED LEARNING TERHADAP KEMAMPUAN PEMECAHAN MASALAH MATEMATIS DITINJAU DARI GENDER DAN LEVEL SEKOLAH Universitas Negeri Padang , Padang , Indonesia E-mail : Abstrak PENDAHULUAN Kemampuan pemecahan masalah merupakan bagian yang penting dal. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *10*(1), 105–116.

Yayat Suharyat, Agus Supriyadi, Ichsan, Erwinsyah satria, T. A. S. (2022). Analisis Pembelajaran daring dalam pembelajaran IPA di SMA/MA di Indonesia Pasca Pandemi Covid-19: Sebuah Literatur Reviews. *Jurnal Pendidikan Dan Konseling*, *4*(5), 1860–1865.

Yusri, A. Y., Matematika, P., Andi, S., & Pangkep, M. (2018). P ENGARUH M ODEL P EMBELAJARAN P ROBLEM B ASED L EARNING TERHADAP K EMAMPUAN P EMECAHAN M ASALAH M ATEMATIKA. *Jurnal "Mosharafa*, *7*, 51–62.

Yustiana el al. (2022). The Effect of E-Learning Based on the Problem-Based Learning Model on Students ' Creative Thinking Skills During the Covid-19 Pandemic. *International Journal of Instruction*, *15*(2), 329–348.

Zhang, Y., Zhou, L., Liu, X., Liu, L., Wu, Y., Zhao, Z., & Yi, D. (2015). The Effectiveness of the Problem-Based Learning Teaching Model for Use in Introductory Chinese Undergraduate Medical Courses : A Systematic Review and Meta- Analysis. *PLos ONE*, *10*(3), 1–24. https://doi.org/10.1371/journal.pone.0120884

Zulyusri, Tomi Apra Santosa , Festiyed, Yerimadesi1, Yohandri, Abdul Razak, S. (2023). Effectiveness of STEM Learning Based on Design Thiking in Improving Critical Thinking Skills in Science Learning : A. *Jurnal Penelitian Pendidikan IPA*, *9*(6), 112–119. https://doi.org/10.29303/jppipa.v9i6.3709