

## IMPROVE STUDENTS' MATHEMATICAL CRITICAL THINKING SKILLS: USING MODELS FOR PROBLEM-BASED LEARNING

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### Abstract

This study's objective was to determine the effects of the problem-based learning model on students enrolled in the mathematics education program at the Islamic University of North Sumatra while they studied to improve their critical thinking skills. This type of quasi-experimental study aims to determine how the participant's parameters are affected by the treatment. "One-group pretest-posttest design" is the name of the study's approach. The research was carried out there with the participation of 35 students from the Mathematics Study Program at the Islamic University of North Sumatra. In this study, data were collected through tests and observations. A tool for data analysis is the t-test. A computer application named SPSS version 25.0 is used to process statistical data. According to the results, using the PBL learning model has an impact on students' mathematical critical thinking skills at the Islamic University of North Sumatra's Mathematics Education Study Program. The t-test significance value of 0.0001, which is less than 0.05, supports this.

**Keywords:** Critical thinking, mathematics learning, problem based learning

### Abstrak

Tujuan dari penelitian ini adalah untuk melihat pengaruh model pembelajaran berbasis masalah dalam membantu mahasiswa di jurusan pendidikan matematika Universitas Islam Sumatera Utara meningkatkan kemampuan berpikir kritis mereka. Jenis penelitian ini adalah kuasi-eksperimental, dengan tujuan untuk menentukan efek terapi pada parameter peserta. The "One-group pretest posttest design" adalah desain penelitian ini. Penelitian berlangsung di Program Studi Pendidikan Matematika Universitas Islam Sumatera Utara dan melibatkan 35 mahasiswa dari Program Studi Matematika. Pengumpulan data dilakukan melalui tes dan observasi dalam penelitian ini. Uji-t digunakan sebagai alat analisis data. Untuk mengolah data statistik, digunakan program komputer bernama SPSS versi 25.0. Berdasarkan hasil temuan, penerapan model pembelajaran PBL berpengaruh terhadap kemampuan berpikir kritis matematis mahasiswa Program Studi Pendidikan Matematika Universitas Islam Sumatera Utara. Hal ini didukung oleh nilai signifikansi uji-t sebesar 0,0001, yang lebih kecil dari 0,05.

**Kata kunci:** Berpikir kritis, pembelajaran berbasis masalah, pembelajaran matematika



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### INTRODUCTION

In accordance with the 2013 curriculum, the significance of critical thinking in mathematics has become the primary agenda item that must be developed. Each student will be able to

use critical thinking skills to increase their performance and problem-solving abilities at a higher level. Critical thinking is a cognitive skill that may be cultivated in the classroom through investigation activities and the active

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participation of students (Afandi, Sajidan, Akhyar, & Suryani, 2019). Students need to be able to think critically in order to solve problems in tough situations and communicate effectively and appropriately. This aligns with one of the aims of 21st-century education: the development of critical thinking skills (Bedir, 2019; Care, Kim, Vista, & Anderson, 2019; Kandari & Qattan, 2020). Thinking of critical can help students solve problems independently in class and in their daily lives. Efforts to develop critical thinking abilities in mathematics education curriculums throughout the world have become a key priority that must be carried out (Ab Kadir, 2018; Aizikovitsh-Udi & Cheng, 2015; Gorev, Telegina, Karavanova, & Feshina, 2018). According to the theoretical framework described above, critical thinking is an essential component of learning in the twenty-first century, particularly when learning mathematics.

However, in actuality, Indonesian students' critical thinking skill in mathematics are still lacking. In general, Indonesian mathematics education focuses on memorizing formulae, calculating, or just applying elementary concepts. In addition, several scoring systems place a premium on the ability to recall information, compute formulae, and apply mathematical concepts to everyday tasks. This type of education system can only produce low-level thinkers (LOTS). Indonesian students were ranked 38th out of 42 nations in the 2018 Trends in International Mathematics and Science Study (TIMSS) and Program for International Student Assessment (PISA) results. This exemplifies Indonesian pupils' dismal performance. According to TIMSS statistics, Indonesian students' difficulties include

those in answering questions that need explanation, mathematical reasoning, finding generalizations or conjectures, and constructing relationships between the data or facts presented. Furthermore, according to PISA statistics, Indonesian students' greatest shortcoming is their inability to apply the mathematical principles they learn to real-world issues. The two TIMSS and PISA statistics clearly reveal that Indonesian students' shortcomings are directly connected to critical thinking indicators.

Students in the Universitas Islam Sumatera Utara's Mathematics Education Study Program also show difficulties in critical thinking abilities. To assess students' critical thinking abilities, researchers utilized three indicators: (i) students were asked to define mathematical ideas; (ii) students were asked to analyze facts or information; and (iii) students were asked to generalize and make conclusions based on the analysis results. According to the findings of the study, students in the Universitas Islam Sumatera Utara's Mathematics Education Study Program were not competent at analyzing facts and information to develop logical conclusions.

According to the findings of interviews with various lecturers, only expository learning models are utilized in the classroom, so students are accustomed to receiving information from lecturers and have little drive to seek information on their own. In the expository learning model, the lecturer transmits the learning information directly to the students. According to Situmorang (2022), expository learning is the process of a lecturer offering instruction to students in a classroom by speaking at the start of the course, explaining the material and presenting

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instances of questions followed by questions and answers. As a result, the learning environment becomes monotonous and dull.

Instead of building students' critical thinking skills, the expository-based learning strategy promotes material knowledge (Heryadi & Sundari, 2020). Expository learning is included in the weak and conventional group since it is motivated by explanations and inquiries about the topic being learned (Qurrata, Merlinda, & Puteri, 2021). The expository learning model inhibits pupils' ability to think at higher levels since they become objects rather than subjects when they learn. As a result, students with low abilities are unable to solve their mathematical difficulties.

According to several studies, students' critical thinking skills can be improved if the lecturer creates a classroom environment that encourages students to think critically (Satiti & Wulandari, 2021). Lecturers not only help students study, but they also urge them to engage actively. Students' critical thinking abilities must continue to grow through the use of numerous appropriate models in teaching critical thinking skills (Widana, 2018). Numerous studies have identified methods or techniques to help students develop their critical thinking skills. Priatna et al. (2020) developed integrated STEM teaching materials based on projects to enhance students' critical thinking skills when studying mathematics. According to Laurens et al. (2018)'s research, realistic learning in the classroom helps students' mathematical critical thinking skills. According to his study, RME had a favorable and significant effect on learners' thinking skills, learning interests, and other aspects of

mathematics learning. The Stimulating Higher-Order-Thinking Skills (Stim-HOTs) model's effectiveness in fostering critical thinking skills was investigated by Saputri et al. (2019). The findings demonstrate that STIM-HOTS enhances students' critical thinking ability.

However, several of the aforementioned strategies have certain disadvantages, such as project-based learning's lengthy duration and high cost. Realistic mathematics learning has a number of drawbacks, including (i) students finding it challenging to figure out the answers on their own because they are used to being given information beforehand; (ii) learning will take a long time to understand for students with low abilities; and (iii) intelligent students are occasionally impatient to wait for other friends who have not finished a task (Do et al., 2021). Similarly, the Stimulating Higher-Order Thinking Skills (Stim-HOTS) learning model has a number of disadvantages, including (i) difficulty managing time, (ii) difficulty facilitating the learning process if there are too many students, and (iii) failure to meet initial learning objectives if the teacher is unreliable (Pramesti, Sajidan, Dwiastuti, & Setyaningsih, 2019).

One of the most relevant learning models is the Problem Based Learning (PBL). PBL is a learning model that is built on constructivism's theoretical underpinning. This Problem Based Learning (PBL) learning technique may be used by students to investigate, study, and solve problems (Abidin et al., 2021). The problem-based learning (PBL) approach has actually been widely applied; for instance, Batdi (2014) and Surya et al. (2018) demonstrated that PBL was more successful than traditional learning in improving students' critical thinking

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skills. But because lecturers' explanations still make up the majority of learning at the Islamic University of North Sumatra, PBL is still used extremely infrequently there. This study aims to determine the impact of problem-based learning on students' thinking skills in the mathematics study program at the Islamic University of North Sumatra.

## METHOD

This is a type of research that is quasi-experimental to determine the effect of the treatment on the parameters of the studied participants. The purpose of this study is to see if the Problem-Based Learning (PBL) learning paradigm has an impact on students in the Universitas Islam Sumatera Utara's Mathematics Education Study Program's mathematics critical thinkingskills. To determine students' thinking skills, a preliminary study is conducted before the research period. Researchers used three indications, such as (1) developing mathematical concepts, (ii) evaluating data, and (iii) generalizing and drawing conclusions from the analysis. Early on, researchers interviewed participants to find issues with learning mathematics, particularly with critical thinking. In the following phase, researchers have designed answers to the problems that emerge. The researcher decides on the suggested course of action, which is implementing a problem-based learning model (PBL), then puts it into practice during the classroom teaching and learning process, assesses the outcomes, and draws conclusions regarding the study findings. draws conclusions regarding the study findings.

The design of this study was inspired by Sugiyono's (2017) "One-group pretest posttest design." The

pretest was done before the treatment, and the posttest was done after the treatment, applying the Problem-Based Learning (PBL) learning model. An overview of how the research design was implemented on Table 1.

Tabel 1. Design RESEARCH

Pretest	Treatment	Posttest
O	X	O

Detailed description:

X : stands for "treatment" (Problem Based Learning Model)

O : Critical thinking ability

The study took place at the Universitas Islam Sumatera Utara's Mathematics Education Study Program. From the first semester through the sixth semester, a total sample of 35 students from the Islamic University of North Sumatra's Mathematics Study Program was selected at random from a population of 115 students. The selection of research subject was based on the fact that students were still enrolled in theoretical classes on campus. While students in semesters 7 and 8 have finished their final projects and field learning practices.

In this study, data was gathered through tests and observations. The observation intends to collect preliminary research data, while the exam aims to get posttest data on critical thinking abilities of students in the Universitas Islam Sumatera Utara's Mathematics Education study program. As a data analysis method, the t-test was performed. Before the t-test, a normality and homogeneity test was done as a prerequisite. Kolmogorov-Smirnov was used for the normality test, while Levene Statistics was used for the homogeneity test. A computer application called SPSS version 25.0 was used to process the statistical data.

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## RESULT

Table 2. Descriptive Statistics

	N	Range	Min	Max	Mean	Std. Error	Std. Deviation	Variance
Pretest Test Result	35	35	45	80	63.00	1.509	8.928	79.706
Posttest Test Result	35	30	60	90	76.43	1.443	8.538	72.899
Valid N (listwise)	35							

The study's findings are displayed in Table 2. As shown in Table 2, the average value of the posttest test (76.43) is greater than the average value of the pretest test (63.00). Table 2 shows that there are mathematical differences between before and after using problem-based learning models to provide treatment. However, an independent sample test is required to determine whether adopting problem-based learning models has a significant impact on the critical thinking skills of

students in the Mathematics Study Program at the Universitas Islam Sumatera Utara. Prerequisite tests, such as the normality and homogeneity tests, must be run prior to the t-test to determine whether the data is normally distributed and homogeneous. The Kolmogorov-Smirnov test was used to determine normality, and the Levene statistic approach was used to determine homogeneity. Table 3 displays the results of the normality test.

Table 3. Results of the normality test

<b>One-Sample Kolmogorov-Smirnov Test</b>			
		<b>Pretest Test Result</b>	<b>Posttest Test Result</b>
N		35	35
Normal	Mean	63.00	76.43
Parameters <sup>a,b</sup>	Std. Deviation	8.928	8.538
Most Extreme Differences	Absolute	.197	.148
	Positive	.131	.109
	Negative	-.197	-.148
Test Statistic		.197	.148
Asymp. Sig. (2-tailed)		.101	.151

According to Table 3, the normality value of the pretest test data is 0.101, and the normality value of the posttest test data is 0.151. Both datasets were deemed to have a significance

level of more than 0.05. As a result, the data utilized in the pretest and posttest were found to be normally distributed. In addition, Table 4 shows the results of the homogeneity test.

Table 4. The Results of the homogeneity test

		<b>Levene Statistic</b>	<b>df1</b>	<b>df2</b>	<b>Sig.</b>
The results of the critical thinking skills test	Based on Mean	.001	1	68	.974
	Based on Median	.043	1	68	.836
	Based on Median and with adjusted df	.043	1	65.543	.836
	Based on trimmed mean	.002	1	68	.966

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The homogeneity value in Table 4 is 0.974, which is larger than 0.05. As a result, the data can be concluded to be homogeneously distributed. The normality and homogeneity tests revealed that the data were normally

distributed and homogeneous, indicating that the necessary test was passed and that the hypothesis could now be tested using the t test. Table 5 shows the results of the t test using the independent simple t test.

Table 5. The Results of the t Test

	t	df	Sig. (2-tailed)
The results of the critical thinking skills test	-6.431	67.865	.000
Equal variances not assumed			.000

According to Table 5, the significance value of t-6,431 is 0.000 less than 0.05, indicating that the usage of problem-based learning models has a significant influence on the mathematical critical thinking abilities of students in the Universitas Islam Sumatera Utara's Mathematics Study

## DISCUSSIONS

The study's findings show that employing the PBL learning model has a significant impact on students in the Universitas Islam Sumatera Utara's Mathematics Education Study Program's mathematical critical thinking skills. The t-test significance value of 0.0001, which is less than 0.05, confirms this. There's also a difference in the average value of the pretest and posttest tests. According to statistical analysis, the posttest score is higher than the score of the pretest test findings. Several researchers, including (Aufa, Rusmansyah, Hasbie, Jaidie, & Yunita, 2021; Kamid, Anggereini, & Muhtadin, 2018; Putri & Hasbi, 2018; Sabur, Saepuloh, & Triana, 2021; Suwarno, Wahidin, & Nur, 2020; Wondo, Meke, & Sao, 2021) have found that using problem-based learning models in learning may increase

investigation, analysis, assessment, and drawing conclusions.

Students are stimulated by high-level questions in the PBL learning model, which trains them to think and analyze information and solving problems (Oktaviana & Haryadi, 2020; Setyaningsih & Rahman, 2022). Students use the thinking process to discover data, analyze the data, evaluate the data, and draw conclusions from the data in order to

solve issues. Students are introduced to problems associated with critical thinking indicators, such as concentrating questions and assessing arguments, as part of the Problem Based Learning model (Ulger, 2018). The second stage is to organize students such that they can learn by paying attention to questions and evaluating a source's authenticity. Students have the chance to identify each problem by organizing learning materials to answer questions to solve challenges. Each student must be able to solve difficulties using a variety of learning tools in this exercise. As a result, this exercise can teach students to employ higher-order thinking abilities when looking for information, gathering sources, and assessing problems. The third step is to guide individual and group studies by

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observing and weighing the findings of observations as well as interacting with others. Investigation is the most important phase in critical thinking exercises, and it will require students to use higher-order thinking skills such as recognizing, analyzing, organizing, comparing, and deriving conclusions from their investigations. Consequently, critical thinking skills may be considerably enhanced through investigative activities. The fourth is generating and presenting the work's outcomes, including making conclusions and reviewing the results of deductions, making inductions, and assessing the consequences of inductions, identifying terms and considering definitions, and identifying assumptions. It's also linked to critical thinking indicators in this section, as students are urged to consider their options carefully while writing reports on investigation findings. The final step is to examine and evaluate the problem-solving process by making judgments, weighing the outcomes, and deciding on a course of action. This is done when students are separated into multiple groups and given a test to sharpen their critical thinking skills and develop a curious mindset (Razak et al., 2022; Sumarni, Rumpaka, Wardani, & Sumarti, 2022).

The goal of PBL is to use critical thinking skills and problem-solving techniques to solve issues (Umar et al., 2020). According to Yusuf and Rahman (2019), the goal of PBL is to improve self-motivation as well as problem-solving, collaboration, and lifelong learning skills. In terms of applicability, the PBL model has a lot of advantages. According to Simamora et al. (2018), the application of the PBL model in learning has several benefits, including: (1) it can help students improve critical

thinking skills, solve problems, and improve intellectual abilities; (2) it can help students learn to collaborate; and (3) it can help students practice their argumentation skills based on valid evidence.

Studi of Erma et al. (2019), who found that when compared to other learning models, the PBL model may increase critical thinking abilities by 72 %. Sari et al. (2020) found that the PBL model is particularly helpful in increasing students' critical thinking abilities when the lecturer is able to guide students to actively learn in problem solving. Furthermore, a study by Ati and Setiawan (2020) found that the PBL model is more successful than problem-solving models in boosting students' critical thinking skills. The adoption of the Problem-Based Learning (PBL) model has a considerable influence on the critical thinking skills of students in the Universitas Islam Sumatera Utara's Mathematics Study Program, according to the findings of this study, which are backed up by numerous additional studies.

## **CONCLUSION AND SUGGESTION**

According to the findings, the problem-based learning model has a significant impact on the mathematical critical thinking skills of students in the Universitas Islam Sumatera Utara's Mathematics Study Program. The PBL program helped students improve their critical thinking skills. The use of problem-based learning models in the classroom can help students develop their research, analysis, evaluation, and conclusion-drawing skills. High-level questions motivate students in the PBL learning approach, which teaches them to think critically, evaluate data, and solve issues. As a consequence, this

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activity can teach students how to employ higher-order thinking abilities when looking for information, accumulating resources, and evaluating challenges. The Problem-Based Learning (PBL) model has a significant impact on the critical thinking skills of students in the Universitas Islam Sumatera Utara's Mathematics Study Program.

This is why the researcher advises lecturers to implement the problem-based learning model into the teaching and learning process, especially to enhance higher-order thinking skills like critical thinking. On the other hand, due to the small sample size and the limited research subjects in the mathematics study program at the Islamic University of North Sumatra, further studies with higher sample sizes are still urgently required to assess the effectiveness of this problem-based learning model.

## REFERENCES

- Ab Kadir, M. A. (2018). An inquiry into critical thinking in the Australian curriculum: examining its conceptual understandings and their implications on developing critical thinking as a “general capability” on teachers’ practice and knowledge. *Asia Pacific Journal of Education*, 38(4), 533–549.  
<https://doi.org/10.1080/02188791.2018.1535424>
- Abidin, Z., Sutarna, Herman, T., Jupri, A., Farokhah, L., Apuanor, & Sonedi. (2021). Gifted Children’s Mathematical Reasoning Abilities on Problem-Based Learning and Project-Based Learning Literacy. *Journal of Physics: Conference Series*, 1720(1).  
<https://doi.org/10.1088/1742-6596/1720/1/012018>
- Afandi, Sajidan, Akhyar, M., & Suryani, N. (2019). Development frameworks of the Indonesian partnership 21 st -century skills standards for prospective science teachers: A Delphi study. *Jurnal Pendidikan IPA Indonesia*, 8(1), 89–100.  
<https://doi.org/10.15294/jpii.v8i1.11647>
- Aizikovitsh-Udi, E., & Cheng, D. (2015). Developing Critical Thinking Skills from Dispositions to Abilities: Mathematics Education from Early Childhood to High School. *Creative Education*, 06(04), 455–462.  
<https://doi.org/10.4236/ce.2015.64045>
- Ati, T. P., & Setiawan, Y. (2020). Efektivitas Problem Based Learning-Problem Solving Terhadap Kemampuan Berpikir Kritis dalam Pembelajaran Matematika Siswa Kelas V. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, 4(1), 294–303.  
<https://doi.org/10.31004/cendekia.v4i1.209>
- Aufa, M. N., Rusmansyah, R., Hasbie, M., Jaidie, A., & Yunita, A. (2021). The Effect of Using e-module Model Problem Based Learning (PBL) Based on Wetland Environment on Critical Thinking Skills and Environmental Care Attitudes. *Jurnal Penelitian Pendidikan IPA*, 7(3), 401–407.  
<https://doi.org/10.29303/jppipa.v7i3.732>
- BATDI, V. (2014). a Meta-Analysis Study Comparing Problem Based Learning With Traditional Instruction. *Elektronik Sosial*

DOI: <https://doi.org/10.24127/ajpm.v11i4.5503>

- Bilimler Dergisi*, 13(51).  
<https://doi.org/10.17755/esosder.12812>
- Bedir, H. (2019). JOURNAL OF LANGUAGE AND LINGUISTIC STUDIES Pre-service ELT teachers' beliefs and perceptions on 21st century learning and innovation skills (4Cs). *Journal of Language and Linguistic Studies*, 15(1), 231–246. Retrieved from [www.jlls.org](http://www.jlls.org)
- Care, E., Kim, H., Vista, A., & Anderson, K. (2019). Education System Alignment for 21st Century Skills: Focus on Assessment. *Center for Universal Education at the Brookings Institution.*, (January), 1–40. Retrieved from <https://www.brookings.edu/wp-content/uploads/2018/11/Education-system-alignment-for-21st-century-skills-012819.pdf>
- Do, T. T., Hoang, K. C., Do, T., Trinh, T. P. T., Nguyen, D. N., Tran, T., ... Nguyen, T. T. (2021). Factors influencing teachers' intentions to use realistic mathematics education in Vietnam: An extension of the theory of planned behavior. *Journal on Mathematics Education*, 12(2), 331–348. <https://doi.org/10.22342/JME.12.2.14094.331-348>
- Erma, E., Koeswanti, H. D., & Giarti, S. (2019). Improving Critical Thinking Skills Using Problem Based Learning on the Media Flash Card. *International Journal for Educational and Vocational Studies*, 1(6), 619–622. <https://doi.org/10.29103/ijevs.v1i6.1671>
- Gorev, P. M., Telegina, N. V., Karavanova, L. Z., & Feshina, S. S. (2018). Puzzles as a didactic tool for development of mathematical abilities of junior schoolchildren in basic and additional mathematical education. *Eurasia Journal of Mathematics, Science and Technology Education*, 14(10), 1–12. <https://doi.org/10.29333/ejmste/93675>
- Heryadi, D., & Sundari, R. S. (2020). Expository learning model. *International Journal of Education and Research*, 8(1), 207–216. Retrieved from [https://www.researchgate.net/publication/339566849\\_EXPOSITORY\\_LEARNING\\_MODEL/link/5e59297b4585152ce8f660f0/download](https://www.researchgate.net/publication/339566849_EXPOSITORY_LEARNING_MODEL/link/5e59297b4585152ce8f660f0/download)
- Kamid, K., Anggereini, E., & Muhtadin, M. (2018). PENERAPAN MODEL PROBLEM BASED LEARNING UNTUK MENINGKATKAN PEMAHAMAN KONSEP MATEMATIKA DITINJAU DARI MULTIPLE INTELLIGENCES SISWA. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 7(2), 192–200. <https://doi.org/10.24127/ajpm.v7i2.1490>
- Kandari, A. M. Al, & Qattan, M. M. Al. (2020). E-Task-Based Learning Approach to Enhancing 21st-Century Learning Outcomes. *International Journal of Instruction*, 13(1), 551–566.
- Laurens, T., Batlolona, F. A., Batlolona, J. R., & Leasa, M. (2018). How Does Realistic Mathematics Education ( RME ) Improve Students ' Mathematics Cognitive Achievement ? *Eurasia Journal of*

DOI: <https://doi.org/10.24127/ajpm.v11i4.5503>

- Mathematics, Science and Technology Education*, 14(2), 569–578.  
<https://doi.org/10.12973/ejmste/76959>
- Oktaviana, D., & Haryadi, R. (2020). PENGARUH MODEL PEMBELAJARAN PROBLEM BASED LEARNING (PBL) TERHADAP KEMAMPUAN PEMECAHAN MASALAH MAHASISWA. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 9(4), 1076–1085.  
<https://doi.org/10.24127/ajpm.v9i4.3069>
- Pramesti, B. N., Sajidan, S., Dwiastuti, S., & Setyaningsih, E. (2019). The feasibility of biology module based on Stim-HOTS models. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 5(1), 101–108.  
<https://doi.org/10.22219/jpbi.v5i1.7385>
- Priatna, N., Lorenzia, S. A., & Widodo, S. A. (2020). STEM education at junior high school mathematics course for improving the mathematical critical thinking skills. *Journal for the Education of Gifted Young Scientists*, 8(3), 1173–1184.  
<https://doi.org/10.17478/JEGYS.728209>
- Putri, F., & Hasbi, M. (2018). KEMAMPUAN BERPIKIR KREATIF MATEMATIS SISWA MELALUI PROBLEM BASED LEARNING. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 7(1), 56–64.  
<https://doi.org/10.24127/ajpm.v7i1.1285>
- Qurrata, V. ., Merlinda, S., & Puteri, R. D. . (2021). Fun and creative learning using discovery learning in Islamic economics: A Technological approach. In *Community Empowerment through Research, Innovation and Open Access* (Vol. 1, pp. 38–42). Retrieved from [https://www.researchgate.net/publication/269107473\\_What\\_is\\_governance/link/548173090cf22525dcb61443/download%0Ahttp://www.econ.upf.edu/~reynal/Civilwars\\_12December2010.pdf%0Ahttps://think-asia.org/handle/11540/8282%0Ahttps://www.jstor.org/stable/41857625](https://www.researchgate.net/publication/269107473_What_is_governance/link/548173090cf22525dcb61443/download%0Ahttp://www.econ.upf.edu/~reynal/Civilwars_12December2010.pdf%0Ahttps://think-asia.org/handle/11540/8282%0Ahttps://www.jstor.org/stable/41857625)
- Razak, A. A., Ramdan, M. R., Mahjom, N., Zabit, M. N. M., Muhammad, F., Hussin, M. Y. M., & Abdullah, N. L. (2022). Improving Critical Thinking Skills in Teaching through Problem-Based Learning for Students: A Scoping Review. *International Journal of Learning, Teaching and Educational Research*, 21(2), 342–362.  
<https://doi.org/10.26803/ijlter.21.2.19>
- Sabur, A., Saepuloh, D., & Triana, R. (2021). Improving Students' Critical Thinking during Covid-19 through Online Learning. *Jurnal Pendidikan Edutama*, 8(2), 61.  
<https://doi.org/10.30734/jpe.v8i2.1334>
- Saputri, A. C., Sajidan, Rinanto, Y., Afandi, & Prasetyanti, N. M. (2019). Improving students' critical thinking skills in cell-metabolism learning using Stimulating Higher Order Thinking Skills model. *International Journal of Instruction*, 12(1), 327–342.  
<https://doi.org/10.29333/iji.2019.12122a>
- Sari, I. P., Supandi, S., & Ariyanto, L. (2020). Pengembangan E-

DOI: <https://doi.org/10.24127/ajpm.v11i4.5503>

- Learning Berbasis Problem Based Learning (PBL) untuk Meningkatkan Kemampuan Berpikir Kritis Matematis Siswa Kelas VII. *Imajiner: Jurnal Matematika Dan Pendidikan Matematika*, 2(2), 102–107. <https://doi.org/10.26877/imajiner.v2i2.5770>
- Satiti, W. S., & Wulandari, K. (2021). Students' Ability To Think Mathematically in Solving PISA Mathematics Problems Content Change and Relationship. *Mathematics Education Journals*, 5(1), 2579–5260. Retrieved from <http://ejournal.umm.ac.id/index.php/MEJ>
- Setyaningsih, R., & Rahman, Z. H. (2022). PENGARUH MODEL PROBLEM BASED LEARNING TERHADAP KEMAMPUAN PEMECAHAN MASALAH SISWA. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 11(2), 1606. <https://doi.org/10.24127/ajpm.v11i2.5098>
- Simamora, R. E., Saragih, S., & Hasratuddin, H. (2018). Improving Students' Mathematical Problem Solving Ability and Self-Efficacy through Guided Discovery Learning in Local Culture Context. *International Electronic Journal of Mathematics Education*, 14(1), 61–72. <https://doi.org/10.12973/iejme/3966>
- Situmorang, H. F. (2022). Learning Strategies for High School Students: Differences in Learning Outcomes Problem Based and Expository. ... *Research and Critics Institute (BIRCI-Journal)* ..., 3877–3885. Retrieved from <https://birci-journal.com/index.php/birci/article/view/4073>
- Sugiyono. (2017). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Bandung: CV. Alfabeta.
- Sumarni, W., Rumpaka, D. S., Wardani, S., & Sumarti, S. S. (2022). STEM-PBL-Local Culture: Can It Improve Prospective Teachers' Problem-solving and Creative Thinking Skills? *Journal of Innovation in Educational and Cultural Research*, 3(2), 70–79. <https://doi.org/10.46843/jiecr.v3i1.45>
- Surya, E., Syahpurta, E., & Juniati, N. (2018). Effect of Problem Based Learning Toward Mathematical Communication Ability and Self-Regulated Learning. *Journal of Education and Practice*, 9(6), 14–23. Retrieved from <https://ojs.unimal.ac.id/index.php/mjml/article/view/741/0>
- Suwarno, S., Wahidin, W., & Nur, S. H. (2020). Project-based learning model assisted by worksheet: It's effect on students' creativity and learning outcomes. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 6(1), 113–122. <https://doi.org/10.22219/jpbi.v6i1.10619>
- Ulger, K. (2018). The effect of problem-based learning on the creative thinking and critical thinking disposition of students in visual arts education. *Interdisciplinary Journal of Problem-Based Learning*, 12(1), 3–6. <https://doi.org/10.7771/1541-5015.1649>
- Umar, U., Kaharuddin, A., Fauzi, A., Widodo, A., Radiusman, R., & Erfan, M. (2020). *A Comparative*

DOI: <https://doi.org/10.24127/ajpm.v11i4.5503>

*Study on Critical Thinking of Mathematical Problem Solving Using Problem Based Learning and Direct Intruction. 465*(Access 2019), 314–316.  
<https://doi.org/10.2991/assehr.k.200827.079>

Widana, I. W. (2018). Higher Order Thinking Skills Assessment towards Critical Thinking on Mathematics Lesson. *International Journal of Social Sciences and Humanities (IJSSH)*, 2(1), 24–32.  
<https://doi.org/10.29332/ijssh.v2n1.74>

Wondo, M. T. S., Meke, K. D. P., & Sao, S. (2021). EFEKTIVITAS PROBLEM-BASED LEARNING SETTING STAD DITINJAU DARI HASIL BELAJAR DAN DISPOSISI MATEMATIS MAHASISWA. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 10(4), 2747.  
<https://doi.org/10.24127/ajpm.v10i4.4271>

Yusuf, M., & Rahman, S. R. (2019). The Implementation of Learning Device using Problem-Based Learning Model to Optimize Students' Science Problem - Solving Skill. *International Journal of Active Learning*, 4(1), 66–70.