EDUMATSAINS
JURNAL PENDIDIKAN MATEMATIKA DAN SAINS
E-ISSN:2527-7235
Volume 10 Issue. 2, October 2025, pp 210-223
http://ejournal.uki.ac.id/index.php/edumatsains

Investigating PBL's Effect on Critical Thinking by Cognitive Style: A Quasi-Experimental Study

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Article Info

Article history:
Received : June 23rd , 2025
Revised : October 23rd, 2025
Accepted : October 30th, 2025
Available online : October 31st, 2025

https://doi.org/10.33541/edumatsains.v10i2.7065

Abstract

Critical thinking skills enable individuals to analyze various perspectives before reaching a conclusion, resulting in more appropriate and successful actions. FI and FD cognitive styles influence how students process information, with FI students tending to be more analytical and independent, while FD students are more dependent on context and external assistance in understanding the material. This research aims to: 1) To investigate the outcome of the impact of PBL method for evaluating students critical thinking abilities, 2) to investigate the variation among FI and FD cognitive styles of students in relation to their critical thinking abilities in the PBL model- applied class. This research employed a quantitative method based on a quasi- experimental configuration with a non-equivalent control group design involving 71 high school students. Data analysis techniques used t-tests and effect size calculations. The conclusion of this research suggest that: 1) The PBL model did not significantly improve students' critical thinking abilities, with the obtained effect size classified as moderate, 2) After learning with the PBL method, compared to students with FD cognitive styles, those with FI cognitive styles had noticeably superior critical thinking skills., where the average score for FI students was higher than that for FD students.

Keywords: cognitive style, critical thinking, problem-based learning

1. Introduction

In a world where information flows in various different and often conflicting ways, critical thinking skills help in determining what is relevant, valid, and valuable. According to Ariadila et al., (2023), critical thinking is the capability to absorb and reflect on information objectively, make effective and appropriate decisions, and identify and solve problems more effectively and efficiently. Critical thinking enables individuals to analyse various perspectives and data before reaching a conclusion, thereby leading to more accurate and successful actions. Sachdeva & Eggen

(2021) suggest that students should be taught and urged to consider the process of acquiring mathematics critically, so that they are equipped to make appropriate decisions when studying the subject in real-world situations. Thus, critical thinking skills play a significant role in education.

Robert H. Ennis in Anggitasari et al., (2021) emphasises that critical thinking is key to helping students reach their full potential to better understand difficult texts and situations by recognising a number of indicators, such as understanding problems, providing justifications supported by relevant data, drawing appropriate conclusions, and verifying the responses given. Suparni (2020) an innovative educational strategy is required to enhance students' critical thinking abilities. Therefore, thinking critically requires an objective and rational assessment of problems from various perspectives, a skill that is often overlooked in mathematics education. This is a very important skill because it can enhance understanding, sharpen cognitive capacity, and facilitate problem-solving. However, mathematical skills for critical thinking are still rarely taken into account when learning mathematics.

Indonesian students have low levels of critical thinking skills. Indonesia ranked quite low in the Programme for International Student Assessment (PISA) in 2015, coming in at 69th out of 75 countries (Susandi, 2021). This is because they are still not accustomed to challenging problems that require various solutions. When studying or solving math problems, students prefer to memorize formulas rather than understand the concepts. This causes students to have difficulty solving math problems that are presented in a different form from the examples given by the teacher (Sitours et al., 2023). This is due to the close relationship among students‘ cognitive styles and their capability for critical thought when tackling mathematical issues. Teachers must understand the relationship between teaching methods and students' critical thinking to create more efficient and effective teaching methods.

Teachers should be aware of the variations in students‘ cognitive styles to assist them develop critical thinking skills. Teaching methods tailored to students’ cognitive styles can improve their ability to think critically about mathematics. Everyone has a unique way of thinking and learning that is influenced by differences in cognitive styles. Pratiwi et al., (2020) argues that cognitive style is one of the characteristics of study that must be taken seriously when creating learning experiences in schools. As a learning variable, cognitive style reflects students' qualities such as motivation, attitude, curiosity, thinking capacity, and so on. Research carried out by Nisa et al., (2024) proved that subjects with an FI cognitive style constantly rechecked their answers, from the stages of completion to the final calculations. Meanwhile, FD students can clearly articulate and communicate the reasons for their chosen problem- solving strategies. FI and FD students have distinct cognitive styles in several ways.

Field-independent (FI) and field-dependent (FD) cognitive styles differ in terms of how students perceive and process information. FD students rely on their surroundings, while FI students solve problems independently, avoiding significant influence from their environment (Akhiroh et al., 2024). Teachers should consider these cognitive style differences when implementing collaborative learning practices, as students who prefer independent learning (FI)

tend to have better mathematical problem-solving skills than those who prefer passive learning (FD) (Nisa et al., 2024).

Harianto (2024) believes that working in groups is encouraged by cooperative learning, which allows students to communicate, exchange ideas, and provide feedback to one another. When students learn to analyze and evaluate various arguments and perspectives from their classmates, this interaction is crucial for the development of critical thinking ability. Numerous studies have demonstrated that by involving students in interactive and collaborative activities, cooperative learning could stimulate students' critical thinking abilities. Through cooperative learning, there are several learning models, such as the jigsaw learning model, group investigation, team game tournament, problem-based learning (PBL), and so on. Among these, the PBL model is particularly efficient for developing mathematical and critical thinking ability in students (Khusniyati et al., 2024).

Problem-based learning (PBL) is a teaching style in which contextual issues are introduced at the beginning of the instructional cycle, providing context and incentives for further learning (Buheji & Buheji, 2020). PBL presents complex real-world challenges that require students to analyse, evaluate, and develop answers. This approach develops students' critical thinking abilities, such as making rational and evidence-based judgements.

This study uses statistics material to develop mathematical critical thinking skills by analysing data, interpreting findings, and drawing conclusions. Statistics material often uses real-world scenarios, making it suitable for the PBL model. This study investigates how students with FI and FD cognitive styles influence their understanding and the ability to solve problems, providing insights as a result of PBL. Therefore, by dividing students into two groups according to FI and FD cognitive styles, PBL model could assess students' mathematical thinking ability.

PBL is related to improving students‘ critical thinking skills. However, its effectiveness also depends on students' cognitive styles, such as FI and FD. The outcome of Dayu et al., (2020) study indicate that the use of PBL strategies can aid students in developing their critical thinking abilities. This is evident when the learning environment becomes more lively and enjoyable, resulting in more meaningful learning and greater student engagement. Problem-based learning strategies have been shown to be effective for students with FI cognitive styles, as they allow for independent work and the organisation of material to find important answers, without being distracted by external contexts. Conversely, students with FD cognitive styles have been found to benefit from the problem-based learning paradigm, as the collaborative atmosphere facilitates understanding of challenges through discussion and peer assistance. However, they may require further guidance to develop increasingly independent critical thinking.

Investigations carried out by Khusniyati et al., (2024) shows that the PBL model's degree of validity could enhance students' capacity for critical thinking when applied to FPB and KPK material in primary school (SD). Similar results were also reported by Dayu et al., (2020), who discovered that students' critical thinking abilitiy increased with the increasing amount of influence

from the PBL approach. Meanwhile, Kalaka (2017) found that PBL is an effective model for teaching probability concepts to students with FI and FD cognitive styles.

Although various studies have shown that Problem-Based Learning (PBL) models are effective in enhancing the capacity for critical thinking, and cognitive styles FI and FD have been proven to influence how students process information and solve problems, there is still very little research that integrates these two aspects. Most previous studies have only focused on the impact of learning models or cognitive styles separately, without considering their interaction within a single learning framework. Additionally, there are not enough studies on the impact of cognitive styles on critical thinking abilities when using the PBL paradigm in secondary education, particularly in high schools. This identifies a research gap that requires further investigation.

This study is novel in terms of its approach and the variables examined. Unlike previous studies, which generally concentrated on how different learning methods or cognitive styles affect critical thinking abilities, this study primarily looks at how critical thinking abilities are impacted by the PBL model and FI and FD cognitive styles. High school students were the subjects of this research, thereby contributing new insights into how students‘ cognitive characteristics interact with problem-based learning approaches. The PBL approach is combined with FI and FD cognitive types in this study to help students become more adept at critical thinking, particularly at the high school stage, is anticipated to provide a scientific contribution to the enhancement of mathematics instruction. In addition, this analysis can serve as a basis for developing teaching techniques that are more suited to students' cognitive characteristics.

With reference to the above explanation, the goal of this studies are: 1) to investigate PBL model's effects on students critical thinking abilities, 2) to investigate the variation among FI and FD cognitive styles of students in relation to their critical thinking abilities in the class that applied PBL model.

2. Method

This study was conducted at a high school in Jakarta during the academic year 2024/2025's even semester using a sample of two grade X classes, totaling 71 students, where the selected subjects had homogeneous characteristics. This research employed quantitative methods that use non-equivalent control groups and are based on quasi-experimental. Abraham & Supriyati (2022) argued that in a non-equivalent control group design, research participants are not chosen at random. This study will be conducted in two different classes using two different approaches to learning, where one experimental class will apply the PBL method, while the other control class will apply the conventional method. The sampling method that will be applied in this investigation is cluster random sampling. Based on Rahman et al., (2022), randomly selecting from the existing population is a sampling technique of cluster random sampling.

Table 1.
Research Design

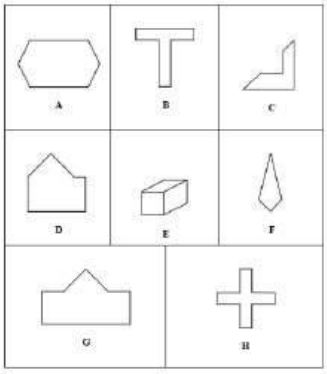
Class	Treatment	*Post-test*
Experimental	X	O_E
Control	–	O_K

Description:
X: Treatment with PBL model
O_E: the experimental class's posttest
O_K: the control class's posttest

The instruments that were used in this investigation to collect data were a posttest of critical thinking skills and a GEFT cognitive style questionnaire for the experimental class. The posttest in this study consisted of six questions, each of which measured one indicator of critical thinking abilities, using essay questions. The FRISCO indicators were used in the development of the test instrument for critical thinking abilities (Focus, Reason, Inference, Situation, Clarity, Overview) developed by Robert H. Ennis in (Setiana & Purwoko, 2020). Changes in the critical thinking abilities of the students in both research groups will be evaluated using the posttest results.

Meanwhile, students' cognitive styles were measured using a cognitive style questionnaire that identified students' tendencies toward dependence (FD) or independence (FI) on their environment when absorbing information. This questionnaire was distributed before the treatment to students based on their cognitive styles. Here is the GEFT questionnaire:

Figure 1.
Simple Form Of GEFT Questionnaire



From the simple shapes above, students are asked to determine the pattern divided into 3 parts. Where part 1 contains 7 simple pattern images as practice exercises, followed by 9

items each for parts 2 and 3 with increasingly complex patterns. The criteria for FI and FD cognitive styles are as followed: students who are able to answer correctly with a score between 0 and 9 are considered to have a FD cognitive style. As for students who were able to answer correctly with a score between 10 and 18 were categorized as belonging to the FI cognitive style.

Table 2.
Criteria for Cognitive Style

Score (s)	Cognitive Style Type
$\mathbf{0 \leq s \leq 9}$	Field Dependent
$\mathbf{10 \leq s \leq 18}$	Field Independent

(Agustiningtyas et al., 2023)

In this study, data analysis methods were implemented in multiple phases. Before the treatment was given, the teacher randomly selected two classes to be used for the study. To ensure equality, normality and homogeneity tests were conducted using the Shapiro-Wilk test and Levene's test. Next, the validity and reliability of the method for assessing critical thinking skills were examined. Validity was assessed by Pearson's correlation, while Cronbach's alpha was utilized to calculate reliability to ensure that the instrument used was appropriate and consistent. After treatment, the scores on the posttest were examined to confirm the hypothesis. Shapiro-Wilk was used to perform the test of normality. The t-test was used to conduct the hypothesis test because the statistics are normally distributed. There are two hypotheses used in this study, the first hypothesis aims to increase students' capacity for critical thinking skills through the PBL model's effects, grounded in the discrepancies among FI and FD cognitive styles, and the second hypothesis intends to investigate the variation among FI and FD cognitive styles of students in relation to their critical thinking abilities in the class that applied PBL model. Additionally, effect size calculations were performed to assess how much the learning model has influenced students' critical thinking abilities based on Cohen's d (1988) in (Widyastuti & Airlanda, 2020).

$$d = \frac{M_2 - M_1}{\sqrt{\frac{SD_1^2 + SD_2^2}{2}}}$$

Description:
M_1: Experimental Class
M_2: Control Class

SD_1: The Standard Deviation for Experimental Class
SD_2: The Standard Deviation for Control Class

Table 3.
Interpretation for Effect Size

Effect size range (d)	Category
$d \leq 0.2$	Small
$0.2 < d \leq 0.5$	Medium
$0.5 < d \leq 0.8$	Large
$d > 0.8$	Very Large

(Widyastuti & Airlanda, 2020)

3. Results and Discussion

This section summarizes the results from data analysis based on two hypotheses proposed in this study. The first hypothesis intends to investigate the outcome of the impact of PBL method for evaluating students critical thinking abilities. The second hypothesis intends to investigate the variation among FI and FD cognitive styles of students in relation to their critical thinking abilities in the class that applied PBL model. The measurement data obtained for the second hypothesis comes from the PBL-based experimental class's posttest results, where prior to the intervention, the experimental class's students were administered the GEFT cognitive style questionnaire to figure out their cognitive style type (FI and FD). To determine the extent of the effect, the data in the analysis utilized inferential statistical tests, reinforced by effect size calculations.

a. First Hypothesis Testing

The first hypothesis intends to investigate the outcome of the impact of PBL method for evaluating students critical thinking abilities. When comparing the post-test results of the experimental class utilizing the PBL method to the control class using conventional method, measurement data was gathered.

Table 4.
Normality test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Experimental Class	.137	34	.107	.942	34	.073
Control Class	.157	34	.034	.946	34	.090

a. Lilliefors Significance Correction

Based on Table 4, The experimental class's Shapiro-Wilk test significance value was 0.073, while the control class's was 0.090. This suggests that the distribution of both classes is normal because they meet the normality assumption, namely sig > 0.05.

Table 5.
Homogeneity test

		Levene Statistic	df1	df2	Sig.
Posttest results	Based on Mean	.663	1	66	.418
	Based on Median	.314	1	66	.577
	Based on Median and with adjusted df	.314	1	62.675	.577
	Based on trimmed mean	.565	1	66	.455

According to Table 5, Levene's test revealed that both research classes posttest results had a significant value of 0.418. This indicates that both classes met the assumption of homogeneity because they met the homogeneity requirement, namely sig

Table 6.
Independent Sample t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Value	Equal variances assumed	.663	.418	1.024	66	.309	3.529	3.446	-3.351	10.410
	Equal variances not assumed			1.024	64.927	.310	3.529	3.446	-3.353	10.412

Based on Table 6, the one class employing the PBL methodology and the class using the other class using conventional method do not differ much, according to the significance value of 0.309 > 0.05. Then, an effect size test according to Cohen's d (1988) was conducted to see how much influence was obtained from the t-test. The effect size for the first hypothesis was 0.2484. Based on Table 3 effect size criteria, this hypothesis falls into the medium category.

Following the application of several learning models, The findings of the t-test and post-test showed that the results indicated no significant gap among the two research classes. However, the effect size calculation results showed that even though it was not statistically significant, the PBL model still contributed positively to improving students' critical thinking abilities, although on a scale that is not yet very strong. Overall, although the statistical results did not show significance, the effect size, which was in the moderate category, indicated that the PBL model still having the capacity to enhance students' critical thinking abilities.

b. Second Hypothesis Testing

The second hypothesis to investigate the variation among FI and FD cognitive styles of students in relation to their critical thinking abilities in the PBL model-applied class. The measurement data obtained for this hypothesis came from the PBL model posttest results of the experimental class's students. Prior to treatment, experimental classes students were administered the GEFT cognitive style questionnaire to establish their cognitive style type (FI and FD).

Table 7.
Normality test

	Statistic	df	Sig.	Statistic	df	Sig.
FI Students	.172	14	.200*	.912	14	.169
FD Students	.234	14	.037	.929	14	.292

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

According to Table 7, students with an FI cognitive style had a significant value of 0.1619 in the Shapiro-Wilk test, while students with an FD cognitive style had a value of 0.292. Since both cognitive style groups have satisfied the normalcy assumption (sig >0.05), this suggests that they are regularly distributed.

Table 8.
Homogeneity test

		Levene Statistic	df1	df2	Sig.
Value	Based on Mean	.123	1	32	.728
	Based on Median	.034	1	32	.855
	Based on Median and with adjusted df	.034	1	29.122	.855
	Based on trimmed mean	.105	1	32	.748

Based on Table 8, the significance value in Levene's test of the posttest results of FI and FD students was 0.728. This indicates that both cognitive style groups met the assumption of homogeneity because they met the homogeneity requirement, namely sig>0.05.

Table 9.
Independent Sample t-test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper

Value	Equal variances assumed	.123	.728	3.054	32	.005	12.614	4.130	4.202	21.027
	Equal variances not assumed			3.154	30.883	.004	12.614	3.999	4.457	20.772

Table 10.
Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
FI Students	14	67	100	87,21	10,577
FD Students	20	47	100	74,60	12,651
Valid N (listwise)	14				

Based on Table 9, Students with a FI and FD cognitive style differ considerably, as indicated by the significance value of 0.005 < 0.05. An effect size test was then conducted using Cohen's d (1988) in (Widyastuti & Airlanda, 2020) to determine the effect size obtained from the t-test. The effect size for the second hypothesis was found to be 1.081. Based on Table 3 effect size criteria, this hypothesis falls into the very large category because it is above the threshold of > 0.8. This indicates that students with cognitive FI and FD types differ greatly in their capacity for critical thinking after learning with the PBL, with FI students averaging 87.21 and FD students averaging 74.60.

Students with cognitive styles FI and FD differ statistically significantly in their capacity for critical thinking, according to the results of the t-test. Furthermore, the effect size results show that there is a considerable comparison between the two classes but it also has a very strong practical impact. It is recognized that students with FI cognitive types achieved higher average calculation results than FD students. This difference indicates that FI students tend to be more capable of developing critical thinking abilities in PBL than FD students. Therefore, this indicates that the PBL approach is more suitable for students who are independent in thinking and learning.

This study found that PBL has not significantly improved students' critical thinking abilities. This contrasts with the study carried out by (Risnawati et al., 2022) the impact by the PBL method for evaluating fifth-grade critical thinking skills of SDN WORA students on the topic of social harmony, which showed a positive and significant effect. That study did not take into account individual student characteristics, such as cognitive style, so the results showed a general and uniform effect. In this study, the effect of the PBL model was analyzed further based on FI and FD cognitive styles. The findings prove that FI and FD students are affected by PBL differently in terms of critical thinking abilities, with FI students achieving higher critical thinking scores. Thus, PBL's impact on critical thinking abilities can be influenced by students' cognitive characteristics, which have not been

the focus of previous studies.

In addition, research carried out by (Dayu et al., 2020) indicates that compared to the learning paradigm utilized in Madiun City's elementary schools, the PBL model is more efficient, especially for fifth-grade students. The outcome of the study show that during cycles 1 and 2 of thematic learning, students' critical thinking abilities increased. For students who passed the KKM, the improvement in critical thinking skills was 30% during the first cycle and 60% during the second cycle. This study indicates that the PBL model is not only relevant for elementary education but can also be implemented at the secondary education level, such as high schools. Thus, the PBL model has broad potential in enhancing students' critical thinking skills across various levels of education.

Additionally, this investigation discovered that students with cognitive styles FI and FD differ statistically significantly in their ability to think critically about mathematics. This is in agreement with the study carried out by (Nisa et al., 2024), which shows that there are differences between FI and FD students in solving critical thinking problems, where students with FI cognitive styles can solve critical thinking problems correctly and meet all mathematical critical thinking indicators. Meanwhile, students with FD cognitive styles can solve critical thinking problems even though they only meet some mathematical critical thinking indicators.

Lastly, research carried out by (Rifqiyana et al., 2016) revealed FD cognitive styles were more prevalent among students than FI cognitive styles. Furthermore, FD subjects were weaker than FI subjects because FD subjects mastered fewer indicators of mathematical critical thinking skills than FI subjects.

4. Conclusion

Considering the outcomes of data analysis and argument, these conclusions were drawn: 1) The PBL methodology did not significantly improve students' critical thinking abilities, with the effect size obtained classified as moderate; 2) After learning with the PBL methodology, there is a substantial inequalities in critical thinking abilities among students with FI and FD cognitive styles, with FI students scoring higher on average than FD students.

This study still has several limitations that need to be considered. First, the number of research subjects is relatively limited and was only conducted in one school, so it cannot be generalized to different populations. Second, limited learning time is also an obstacle in optimizing the application of the learning model. Since the PBL model did not succeed to demonstrate a statistically meaningful impact in this investigation, Future studies should concentrate on improving the quality of PBL implementation. Furthermore, since cognitive style was found significantly impact one's capacity for critical thinking abilities in this study, future research could explore other individual factors.

5. References

Abraham, I., & Supriyati, Y. (2022). DESAIN KUASI EKSPERIMEN DALAM PENDIDIKAN:

LITERATUR REVIEW. Jurnal Ilmiah Mandala Education, 8(3), 2476–2482. https://doi.org/10.58258/jime.v8i3.3800

Agustiningtyas, I. T., Trapsilasiwi, D., Yudianto, E., Fatahillah, A., & Oktavianingtyas, E. (2023). KEMAMPUAN REPRESENTASI MATEMATIS SISWA DALAM MENYELESAIKAN MASLAAH MATEMATIKA DITINJAU DARI GAYA KOGNITIF FIELD DEPENDENT DAN FIELD INDEPENDENT. Jurnal Riset Pendidikan Dan Inovasi Pembelajaran Matematika (JRPIPM), 6(2), 187–198. https://doi.org/10.26740/jrpipm.v6n2.p187-198

Akhiroh, M., Zawawi, I., & Khikmiyah, F. (2024). PENGARUH GAYA KOGNITIF FI-FD DAN MINAT BELAJAR TERHADAP PEMAHAMAN KONSEP MATEMATIKA PADA MATERI SEGITIGA DAN SEGIEMPAT. JPMI (Jurnal Pembelajaran Matematika Inovatif), 6(6), 2163–2172. https://doi.org/10.22460/jpmi.v6i6.17749

Anggitasari, V., Widyaningrum, T., Utari, S., Guru, P. P., Dahlan, U. A., Guru, P. P., & Dahlan, U. A. (2021). PENGEMBANGAN BERPIKIR KRITIS MELALUI ANALISIS JURNAL. 1(1), 1954–1960.

Ariadila, S. N., Silalahi, Y. F. N., Fadiyah, F. H., Jamaluddin, U., & Setiawan, S. (2023). ANALISIS PENTINGNYA KETERAMPILAN BERPIKIR KRITIS TERHADAPPEMBELAJARAN BAGI SISWA. Jurnal Ilmiah Wahana Pendidikan, 9(20), 664–669.

Buheji, M., & Buheji, A. (2020). CHARACTERISTICS OF 'PROBLEM-BASED LEARNING' IN POST-COVID-19 WORKPLACE. Human Resource Management Research, 10(2), 33–39. https://doi.org/10.5923/j.hrmr.20201002.02

Dayu, D. P. K., Pratiwi, C. P., & Hakim, P. R. (2020). PROBLEM-BASED LEARNING MODEL TO INCREASE STUDENTS' CRITICAL THINKING. Jurnal Basicedu, 5(5), 3(2), 524–532. https://journal.uii.ac.id/ajie/article/view/971

Harianto, B. B. (2024). EMBRACING COOPERATIVE LEARNING FOR CRITICAL THINKING AND ENHANCED LEARNING OUTCOMES. East Asian Journal of Multidisciplinary Research, 3(5), 1709–1720. https://doi.org/10.55927/eajmr.v3i5.9325

Kalaka, F. R. S. (2017). PENGARUH MODEL PROBLEM BASED LEARNING TERHADAP HASIL BELAJAR MATEMATIKA DITINJAU DARI GAYA KOGNITIF PESERTA DIDIK. Jurnal Riset Dan Pengembangan Ilmu Pengetahuan, 02(1), 22–27.

Khusniyati, L., Hapsary, N. A., & Anisa, S. (2024). META ANALISIS :EFEKTIVITAS MODEL PEMBELAJARAN PROBLEM BASED LEARNING TERHADAP KEMAMPUAN BERPIKIR KRITIS PADA PELAJARAN MATEMATIKA SD MATERI KPK DAN FPB. 10, 1487–1497.

Nisa, N. A., Prayitno, S., Hikmah, N., & ... (2024). ANALISIS KEMAMPUAN BERPIKIR KRITIS MATEMATIS POKOK BAHASAN ARITMATIKA SOSIAL DITINJAU DARI GAYA KOGNITIF SISWA. Journal of Classroom, 6(1). https://jppipa.unram.ac.id/index.php/jcar/article/view/5968%0Ahttps://jppipa.unram.ac.id/index.php/jcar/article/download/5968/4549

Pratiwi, D. P., Sujiran, S., & Puspananda, D. R. (2020). ANALISIS KEMAMPUAN BERFIKIR KRITIS DALAM MEMECAHKAN MASALAH SISTEM PERSAMAAN LINEAR SATU

VARIABEL DITINJAU DARI GAYA KOGNITIF SISWA. Jurnal Pendidikan Edutama, 1–11.

Rahman, M. M., Tabash, M. I., Salamzadeh, A., Abduli, S., & Rahaman, M. S. (2022). SAMPLING TECHNIQUES (PROBABILITY) FOR QUANTITATIVE SOCIAL SCIENCE RESEARCHERS: A CONCEPTUAL GUIDELINES WITH EXAMPLES. SEEU Review, 17(1), 42–51. https://doi.org/10.2478/seeur-2022-0023

Rifqiyana, L., Masrukan, M., & Susilo, B. E. (2016). ANALISIS KEMAMPUAN BERPIKIR KRITIS SISWA KELAS VIII DENGAN PEMBELAJARAN MODEL 4K DITINJAU DARI GAYA KOGNITIF SISWA. Unnes Journal of Mathematics Education, 5(1). https://doi.org/10.15294/ujme.v5i1.8608

Risnawati, A., Nisa, K., & Oktaviyanti, I. (2022). PENGARUH MODEL PEMBELAJARAN PROBLEM BASED LEARNING TERHADAP KEMAMPUAN BERPIKIR KRITIS SISWA KELAS V PADA TEMA KERUKUNAN DALAM BERMASYARAKAT SDN WORA. Jurnal Ilmiah Profesi Pendidikan, 7(1), 109–115. https://doi.org/10.29303/jipp.v7i1.426

Sachdeva, S., & Eggen, P.-O. (2021). LEARNERS' CRITICAL THINKING ABOUT LEARNING MATHEMATICS. International Electronic Journal of Mathematics Education, 16(3), em0644. https://doi.org/10.29333/iejme/11003

Setiana, D. S., & Purwoko, R. Y. (2020). ANALISIS KEMAMPUAN BERPIKIR KRITIS DITINJAU DARI GAYA BELAJAR MATEMATIKA SISWA. Jurnal Riset Pendidikan Matematika, 7(2), 163–177. https://doi.org/10.21831/jrpm.v7i2.34290

Sitours, B. R., Yani T, A., Yundari, Y., Zubaidah, Z., & Hamdani, H. (2023). PENGEMBANGAN BAHAN AJAR BERBANTUAN MICROSOFT SWAY UNTUK MENINGKATKAN PEMAHAMAN KONSEP DAN KEMAMPUAN BERPIKIR KRITIS PESERTA DIDIK DALAM PEMBELAJARAN DARING. EduMatSains : Jurnal Pendidikan, Matematika Dan Sains, 8(1), 21–34. https://doi.org/10.33541/edumatsains.v8i1.4516

Suparni, S. (2020). UPAYA MENINGKATKAN KEMAMPUAN BERPIKIR KRITIS MAHASISWA MENGGUNAKAN BAHAN AJAR BERBASIS INTEGRASI INTERKONEKSI. Jurnal Derivat: Jurnal Matematika Dan Pendidikan Matematika, 3(2), 40–58. https://doi.org/10.31316/j.derivat.v3i2.716

Susandi, A. D. (2021). CRITICAL THINKING SKILLS OF STUDENTS IN SOLVING MATHEMATICAL PROBLEM. Numerical: Jurnal Matematika Dan Pendidikan Matematika, 5, 115–128. https://doi.org/10.25217/numerical.v5i2.1865

Widyastuti, R. T., & Airlanda, G. S. (2020). EFEKTIVITAS MODEL PROBLEM BASED LEARNING TERHADAP KEMAMPUAN PEMECAHAN MASALAH MATEMATIKA SISWA SEKOLAH DASAR. Jurnal Basicedu, 5(5), 1120–1129. https://journal.uii.ac.id/ajie/article/view/971