Prisma Sains: Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA IKIP Mataram
https://e-journal.undikma.ac.id/index.php/prismasains/index
e-mail: prismasains.pkpsm@gmail.com

July 2025. Vol. 13, No. 3
p-ISSN: 2338-4530
e-ISSN: 2540-7899
pp. 533-545

The Role of Mathematical Resilience in Critical Thinking Development Under PBL Models

Dellia Mila Shopia, *Mas Roro Diah Wahyu Lestari
Elementary School Teacher Education, Faculty of Educational Sciences, Muhammadiyah Jakarta University, Jl. K.H. Ahmad Dahlan, Cireundeu, Banten, 15419, Indonesia
*Corresponding Author e-mail: masrorodiah@umj.ac.id

Received: April 2025; Revised: June 2025; Published: July 2025

Abstract

This study investigates the impact of the Problem-Based Learning (PBL) model on elementary students' mathematical critical thinking skills and resilience. Employing a quasi-experimental design with a pretest-posttest control group, the research involved 45 fifth-grade students divided into experimental and control groups. Validated instruments, aligned with higher-order thinking and affective constructs, were used to assess critical thinking and mathematical resilience. Quantitative findings demonstrated that the PBL model led to statistically significant improvements in both constructs. Students in the experimental group outperformed their peers, with large effect sizes (Cohen's d = 2.51 for critical thinking, 2.35 for resilience), and the Mann-Whitney U test confirmed significant intergroup differences. Furthermore, Spearman correlation analysis ($r = 0.460$, $p < 0.05$) revealed a moderate positive relationship between resilience and critical thinking. Qualitative analysis showed that students with higher resilience provided more reflective and elaborate responses. The study emphasizes the educational potential of integrating affective-cognitive instructional models. PBL not only enhances academic performance but also supports students' emotional persistence and adaptability in learning mathematics. However, limitations such as small sample size and sampling method should be considered in interpreting the results. The study concludes that fostering mathematical resilience is essential to optimizing the cognitive benefits of PBL and recommends teacher training and curriculum strategies to implement this dual-focused approach effectively.

Keywords: Problem-Based Learning; Critical Thinking; Mathematical Resilience; Elementary Education

How to Cite: Shopia, D. M., & Lestari, M. R. D. W. (2025). The Role of Mathematical Resilience in Critical Thinking Development Under PBL Models. *Prisma Sains : Jurnal Pengkajian Ilmu Dan Pembelajaran Matematika Dan IPA IKIP Mataram*, *13*(3), 533–545. https://doi.org/10.33394/j-ps.v13i3.16704

https://doi.org/10.33394/j-ps.v13i3.16704

INTRODUCTION

Education in the 21st century is tasked with developing students who are not only knowledgeable but also capable of critical reasoning, problem-solving, and adapting to rapid changes. This imperative is often framed in terms of the "4Cs": Critical thinking, Communication, Collaboration, and Creativity (Pertiwi & Rizal, 2020). Mathematics, as a foundational discipline, plays a central role in this framework. It equips learners with logical reasoning, analytical skills, and precision in thought. However, despite its importance, mathematics remains a subject perceived by many elementary students as difficult and intimidating, often leading to disengagement and underperformance (Merianah, 2019) The national trend in Indonesia echoes this concern, with many students demonstrating minimal proficiency in problem-solving tasks requiring higher-order thinking skills. Similar observations have been reported globally, notably in international assessments such as PISA, which identify persistent gaps in students' mathematical literacy and reasoning.

This disconnect is particularly acute in early education, where the development of mathematical critical thinking skills is crucial. One dimension often overlooked in addressing this challenge is the role of affective traits—specifically, mathematical resilience. Dweck conceptualizes resilience as a positive adaptive stance in facing learning difficulties (Hendriana et al., 2017). In mathematics, resilience allows students to persist through complex and unfamiliar problems without surrendering to frustration or failure. Studies have shown that students with high levels of mathematical resilience tend to outperform their peers in critical thinking tasks, suggesting a significant interplay between affective and cognitive domains (Dilla et al., 2018; Hendriana et al., 2017; C. Lee & Johnston-Wilder, 2017). Yet, many existing curricular designs and instructional strategies continue to prioritize content delivery over psychological preparedness, leaving students ill-equipped to engage in critical mathematical reasoning.

The issue is particularly pronounced in underperforming elementary schools, such as SDN Pondok Kacang Timur 04, where interviews with teachers revealed that over 50% of students score below the minimum competency threshold. These students often report feeling bored, overwhelmed, and disengaged with mathematical content. It is in such contexts that a pedagogical shift becomes essential. Educators must not only teach mathematical content but also foster affective capacities like resilience. A promising avenue for this dual development is Problem-Based Learning (PBL) an instructional approach centered on engaging students in real-world, open-ended problems that require critical thinking, collaboration, and iterative problem-solving.

PBL has been widely recognized for its potential to develop critical thinking by involving learners in authentic inquiry (Mardiah et al., 2022; Sianturi et al., 2018) The method challenges students to construct meaning, generate hypotheses, test solutions, and reflect on their learning processes. Furthermore, because PBL is inherently learner-centered and interactive, it may provide a supportive context in which students can develop the resilience needed to cope with academic challenges. Research increasingly supports this view: students in PBL settings report higher levels of motivation, engagement, and perseverance (N. N. A. P. Dewi & Agustika, 2023; Julfianto et al., 2022). Nevertheless, the theoretical and empirical bases for understanding how resilience operates within PBL environments remain underdeveloped, especially for low-performing students.

Existing literature identifies several frameworks to conceptualize the relationship between cognitive and affective learning outcomes. Self-Determination Theory (SDT), for instance, posits that the satisfaction of autonomy, competence, and relatedness promotes both intrinsic motivation and adaptive behaviors like resilience (Molina-Muñoz et al., 2023). Similarly, Dweck's Growth Mindset Theory asserts that beliefs about the malleability of intelligence can buffer against the negative impacts of failure, encouraging sustained cognitive effort (Rademacher, 2022). Empirical studies show that students with high resilience tend to maintain focus during complex problem-solving, suggesting that resilience facilitates the cognitive processes necessary for critical thinking (Y. S. Dewi et al., 2023; Nabilah et al., 2024)

Despite these insights, significant gaps remain. Few studies have examined resilience not just as an outcome but as a *moderating* or *mediating* variable in learning models like PBL. When viewed as a moderator, resilience could influence how students benefit from PBL interventions; when viewed as a mediator, it may explain the mechanism through which PBL affects critical thinking outcomes (Avvisati & Borgonovi, 2020; Sánchez Barroso et al., 2020). Understanding this dynamic is especially critical for low-performing students, who often lack the emotional coping strategies necessary to persist in rigorous academic environments (Tambunan, 2021). Moreover, there is limited qualitative research exploring how students with different levels of resilience experience PBL differently, which could provide valuable insights into tailoring pedagogical approaches for diverse learners.

This study aims to address these gaps by examining the effect of the Problem-Based Learning (PBL) model on elementary students' mathematical critical thinking skills, while considering the role of mathematical resilience as a moderating variable. Specifically, the research investigates whether students with varying levels of resilience respond differently to

PBL and whether resilience significantly correlates with critical thinking outcomes. The study contributes to the existing literature by (1) integrating cognitive and affective variables in the analysis of PBL efficacy, (2) focusing on a population of low-performing students often underrepresented in such research, and (3) offering empirical insights that may inform teacher training, curriculum design, and intervention programs. The novelty lies in exploring not only the cognitive benefits of PBL but also its capacity to foster emotional readiness for mathematical challenges, thereby supporting a more holistic view of learning.

METHOD

Research Design

This study adopted a quasi-experimental research design utilizing a pretest-posttest control group approach to evaluate the influence of the Problem-Based Learning (PBL) model on students' mathematical critical thinking skills, considering mathematical resilience as a moderating factor. The design enabled the researcher to measure the differences in outcomes between an experimental group, which received the PBL intervention, and a control group, which followed conventional instruction. The structure of the experimental framework is presented in Table 1. In this design, both groups underwent an initial pretest (denoted as O) followed by respective instructional treatments (X_1 for the PBL group and X_2 for the conventional group), and finally a posttest (O) to assess the intervention effects.

Table 1. Matching Design Pre-test Post-test Control Group Design

Group	Pretest	Treatment	Post test
Experiment	O	X1	O
Control	O	X2	O

Participants and Sampling

The research was conducted at SDN Pondok Kacang Timur 04 in South Tangerang, Indonesia, involving fifth-grade students. A total of 45 students participated, comprising 25 students in class VA (experimental group) and 20 students in class VB (control group). Participants were selected using purposive sampling, which is common in educational research for targeting specific characteristics or learning environments relevant to the study objectives. While purposive sampling facilitates in-depth exploration of particular educational contexts (Haslberger et al., 2023), it also introduces limitations such as reduced generalizability and potential researcher bias (Nanni et al., 2022; Pitt et al., 2024; Singkhorn et al., 2023). Nevertheless, this method was appropriate given the study's focus on classrooms with demonstrably low performance in mathematics and a need to evaluate intervention effectiveness in such environments.

Research Instruments

Two instruments were employed to gather data: a mathematical critical thinking test and a mathematical resilience questionnaire. Both instruments underwent rigorous validation using the Rasch Model and expert reviews to ensure psychometric soundness.

The mathematical critical thinking test consisted of several open-ended problems designed to evaluate students' abilities across four cognitive domains as outlined by (Rosliani & Munandar, 2022)): (1) *Interpretation*, which measured the ability to identify known and unknown information from the problem; (2) *Analysis*, which assessed the skill of translating problems into mathematical models and recognizing relational structures; (3) *Evaluation*, which tested the accuracy and appropriateness of calculation strategies; and (4) *Inference*, which evaluated the ability to derive logical conclusions based on given data. These indicators were integrated into the test design, ensuring alignment with higher-order thinking competencies relevant to elementary mathematical problem-solving.

The mathematical resilience questionnaire, adapted from the frameworks of (Faradillah & Septiana, 2022; Kooken et al., 2016), included 29 items—20 positively worded and 9 negatively worded—distributed across four core dimensions of resilience: Value, Struggle, Growth, and Resilience. The Value dimension measured students' beliefs about the relevance and importance of learning mathematics; Struggle captured their recognition of difficulty as a natural part of mathematical learning; Growth assessed their belief in personal capacity to improve mathematically; and Resilience reflected their responses to challenging or adverse mathematical situations. Table 2 outlines the distribution of items per indicator, showing the comprehensive coverage of resilience components within the instrument.

Table 2. Indicator Resilience

Indicator	Many Items
Struggle	3
Resilience	14
Value	6
Growth	6
Total	29

Validation of both instruments was conducted using the **Rasch Model**, a robust psychometric method for evaluating the fit and reliability of assessment tools. The Rasch analysis examined key metrics including Outfit Mean Square (MNSQ), Outfit Z-Standardized (ZSTD), and Point Measure Correlation (PTMEA-CORR), with acceptable ranges set at 0.5–1.5 for MNSQ, -2.0 to +2.0 for ZSTD, and 0.4–0.85 for PTMEA-CORR, as indicated in Table 3 (Sumintono & Widhiarso, 2014). Results demonstrated that all items in both the critical thinking test and resilience questionnaire fell within acceptable fit thresholds, confirming their suitability for data collection. Furthermore, the reliability of the instruments was confirmed by high Cronbach's Alpha values: 0.95 for the critical thinking test and 0.84 for the resilience questionnaire, indicating very high internal consistency (Faradillah & Febriani, 2021).

Table 3. Fit Indicates (Sumintono & Widhiarso, 2014)

Statistics	Outfit Mean Square Values (MNSQ)	Outfit Z-Standardized Values (ZSTD)	Point Measure Correlation (PTMEA-CORR)
Fit Indicators	0.5 – 1.5	(-2.0) – (+2.0)	0.4 – 0.85

Data Collection Procedure

The research was conducted in three sequential phases. Initially, all participants completed the pretest assessments, which included the critical thinking test and the resilience questionnaire. Following this, the instructional intervention took place over a designated period, during which the experimental group received PBL-based mathematics instruction characterized by problem-centered inquiry, collaborative exploration, and guided reflection. In contrast, the control group continued with traditional teacher-centered instruction. At the end of the intervention phase, both groups were administered the posttest using the same instruments to measure changes in the targeted variables.

The implementation adhered to ethical research protocols. Approvals were secured from the school administration, and both students and their parents were informed of the research objectives and procedures. Participation was voluntary, and confidentiality was maintained throughout the study.

Data Analysis Techniques

Data were analyzed quantitatively using IBM SPSS version 24. Prior to inferential testing, assumptions regarding normality were examined. Since the data did not meet parametric assumptions, the non-parametric Mann-Whitney U test was used to compare the performance between the experimental and control groups on both critical thinking and resilience scores. To determine the magnitude of differences, Cohen’s d effect size was calculated using the criteria established by (Sawilowsky, 2009), which classifies effect sizes as low (0–0.01), moderate (0.01–0.2), high (0.2–0.5), and very high (>0.5). These interpretations provided insight into the educational significance of the observed differences.

Additionally, Spearman's rank correlation was employed to examine the relationship between students’ levels of mathematical resilience and their performance in critical thinking tasks. This statistical approach was suitable for exploring the strength and direction of associations within the non-normally distributed dataset.

The combination of these analytical techniques allowed for a nuanced understanding of the impact of PBL on students’ mathematical thinking and the role of resilience as a potential moderator, thereby supporting the study’s aim of integrating cognitive and affective dimensions in mathematics education.

RESULTS AND DISCUSSION

Comparison of Mathematical Critical Thinking Skills

The post-test results revealed significant differences in mathematical critical thinking skills between the experimental and control groups. Based on the Mann-Whitney U test, students in the experimental group, who were taught using the Problem-Based Learning (PBL) model, achieved a mean score of 26.16, while the control group, which received conventional instruction, scored a mean of 19.05 (Table 5). The resulting Asymp. Sig. (2-tailed) value of 0.001 indicates a statistically significant difference ($p < 0.05$), suggesting that the PBL intervention had a positive impact on enhancing students' critical thinking abilities. This finding aligns with previous literature which shows that PBL significantly improves elementary students' critical thinking through active problem engagement (Astuti et al., 2023; Ata et al., 2023).

Table 4. Mann Whiteney Test Results of Mathematical Critical Thinking Ability Test and Mathematical Resilience Questionnaire

		Critical Thinking Skills		Mathematical Resilience	
		Experiment	**Control**	**Experiment**	**Control**
N	Valid	20	20	20	20
	Missing	0	0	0	0
Mean		26.16	19.05	32.48	11.15
Mann-Whitney U		171.00		13.00	
Asymp. Sig. (2-tailed)		.068		.000	

Mathematical Resilience Profile

In terms of mathematical resilience, students in the experimental group demonstrated a markedly higher mean score (32.48) compared to the control group (11.15) (Table 5). The Mann-Whitney U value of 13.00 and a significance value of 0.001 confirmed the presence of a statistically significant difference between the groups. Figure 1 (Wright Map) further illustrates the distribution of student resilience levels across both groups. As shown in Table 8, the majority of students (75.5%) fell into the moderate resilience category, with 15.5% classified as low and 8.8% as high. Notably, students with high resilience were predominantly found in the PBL group, supporting the notion that PBL fosters resilience by immersing students in problem-solving contexts that demand persistence and adaptive effort (Y. S. Dewi et al., 2023).

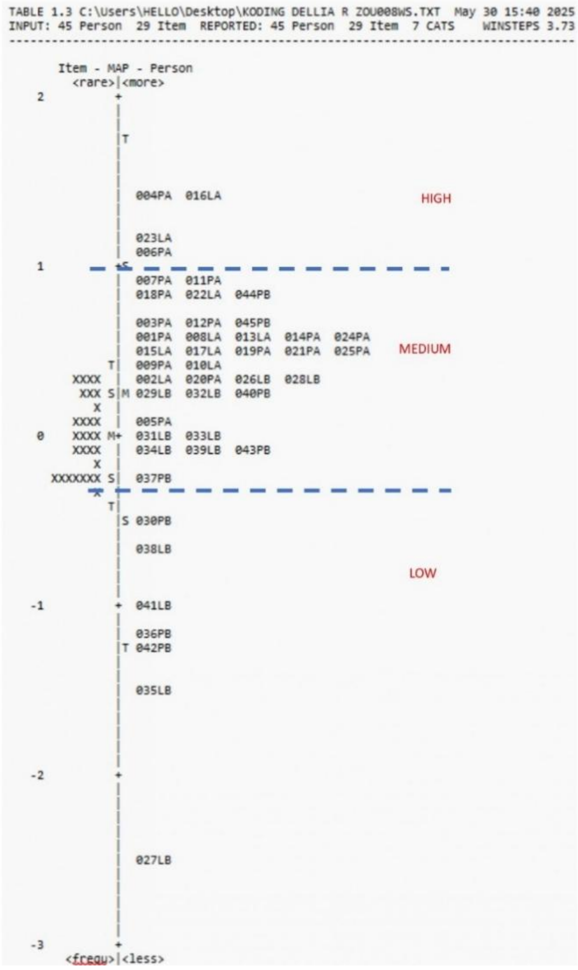


Figure 1. Figure person wright maps category of respondents' mathematical resilience

Effect Size Analysis

To assess the practical significance of the intervention, effect sizes were calculated using Cohen's d. As shown in Table 6, the effect size for critical thinking skills was 2.51, and for mathematical resilience, 2.35—both categorized as large effects based on (Sawilowsky, 2009)interpretation. These values indicate not only statistical significance but also substantial practical impacts, confirming the robustness of the PBL model in enhancing students' cognitive and affective learning outcomes. Such strong effect sizes reinforce findings from earlier studies reporting the substantial benefits of PBL in educational settings (Kusuma & Busyairi, 2023; Laswadi et al., 2023)

Table 5. Cohen's effect size test on mathematical creative thinking ability and mathematical resilience

Aspect	Control Group		Experimental Group		d
	Mean	SD	Mean	SD	
Mathematical Critical Thinking Skills	58.50	17.54	93.00	8.27	2.51
Mathematical Resilience	46.25	26.17	65.25	10.55	2.35

Correlation between Critical Thinking and Resilience

The relationship between students' mathematical critical thinking skills and resilience was examined using Spearman correlation analysis. Table 7 shows a correlation coefficient of

0.460 (p = 0.001), indicating a moderate but statistically significant positive correlation. This finding suggests that students with higher resilience tend to exhibit stronger critical thinking skills. The empirical correlation is consistent with research by (Y. S. Dewi et al., 2023), which found that nearly 80% of problem-solving performance could be attributed to resilience levels, and with (Khoshgoftar et al., 2023), who reported a similar relationship in higher education contexts.

Table 6. Spearman correlation of mathematical critical thinking ability and mathematical resilience

		Mathematical Critical Thinking Skills	**Mathematical Resilience**
Mathematical Critical Thinking Skills	Correlation Coefficient	1,000	0.460**
	Sig. (2-tailed)	.	0.001
	N	40	40
Mathematical Resilience	Correlation Coefficient	.460**	1,000
	Sig. (2-tailed)	.001	.
	N	40	40

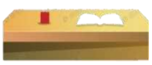
**Correlation is significant at the 0.01 level

Qualitative Analysis of Student Work Based on Resilience Level

Figure 2 displays the post-test instrument used to assess critical thinking, while Figures 3, 4, and 5 illustrate student responses categorized by resilience levels. Students with high resilience (Figure 3) successfully completed all test items with accuracy, demonstrating mastery of all four indicators: Interpretation, Analysis, Evaluation, and Inference. These students approached challenges with confidence and reflected a growth mindset, consistent with the findings of (Nusaibah et al., 2024; Zanthy, 2018).

Critical Thinking Ability Instrument Post-Test Questions

1. Lisa's study table measures 2 m long and 1.5 m wide. How wide is Lisa's table?



2. Mother bought a carpet measuring 1.75 m long and 1.5 m wide. How wide is her carpet?

3. Mr. Toni has a plot of garden that will be planted with various types of fruits and vegetables. The size of Mr. Toni's garden is 8.1 m long and 5.5 m wide. How much? m^2 How big is Mr. Toni's garden?

4. On Sunday, Yudi and his father will make a chicken coop behind his house. The chicken coop will be made with a length of 2.05 m and a width of 1.4 m. How much?m^2How wide is Yudi's drum?

5. Cantika owns a cake shop. In one day she needs 5.35 kg of wheat flour to make cakes. How many kg of wheat flour does Cantika need for 1 week?

Figure 2. Critical Thinking Ability Instrument Post-test Questions

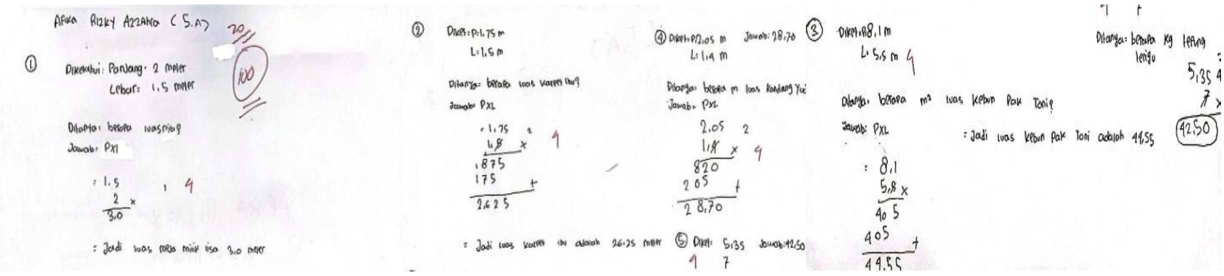


Figure 3. Post-test response results of mathematical thinking skills with high mathematical resilience

Moderate-resilience students (Figure 4) typically demonstrated partial success. For example, student 021PA fulfilled the Interpretation and Evaluation indicators but failed to engage in Analysis and Inference tasks. These students showed signs of anxiety and hesitation, corroborating findings by (Septiana & Faradillah, 2022).

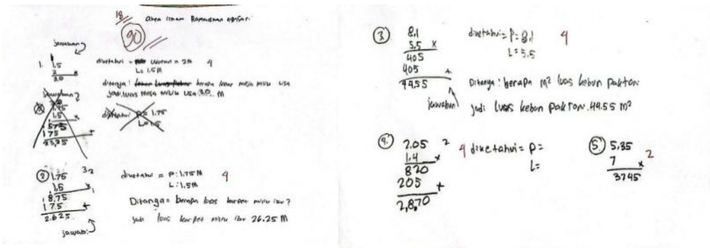


Figure 4. Post-test response results of mathematical thinking ability with moderate mathematical resilience

In contrast, students with low resilience (Figure 5) struggled significantly. While student 027LB attempted several items, their responses lacked accuracy and coherence, particularly on Analysis and Inference. This pattern reflects a lack of persistence and conceptual understanding, which aligns with the behaviors described by (Alyani & Putri, 2022).

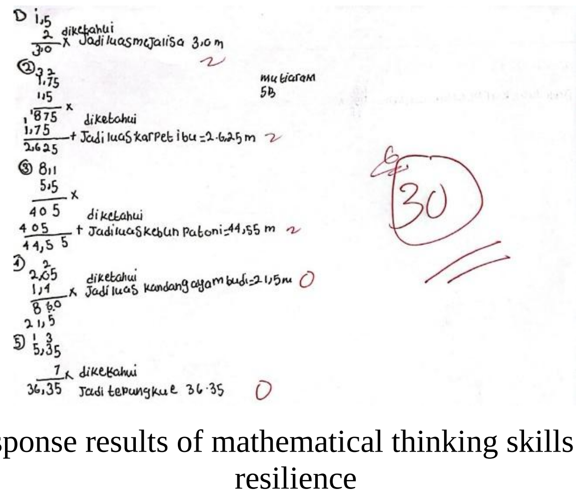


Figure 5. Post-test response results of mathematical thinking skills with low mathematical resilience

Collectively, the qualitative and quantitative data provide compelling evidence that resilience not only correlates with but also differentiates students' performance in problem-based learning settings. High-resilience students tend to show greater initiative, flexibility, and reflective capacity, whereas low-resilience peers often withdraw or underperform in the face of cognitive demands. These findings validate the hypothesis that fostering mathematical resilience is essential to optimizing the benefits of PBL interventions.

Discussion

The findings of this study substantiate the role of the Problem-Based Learning (PBL) model as a pedagogical strategy that effectively enhances both cognitive and affective learning outcomes, particularly mathematical critical thinking and resilience among elementary students. By comparing post-test scores, calculating effect sizes, and analyzing correlations, it became evident that students exposed to PBL showed substantial improvements in critical thinking skills and higher levels of mathematical resilience. This section discusses these outcomes through the lens of established affective-cognitive theories and previous empirical research.

The observed correlation between resilience and critical thinking aligns with the foundational tenets of Growth Mindset Theory, which posits that students who believe their abilities can be developed through dedication and effort are more likely to embrace challenges and persist through difficulties (Jamaluddin et al., 2023; Mohamoud, 2024). In our study, students in the PBL group demonstrated significantly greater resilience, which in turn translated into better critical thinking outcomes, as visualized in Table 5 and Figures 3 to 5. These students illustrated the hallmarks of a growth mindset: persistence, self-reflection, and an ability to reframe setbacks as learning opportunities.

Expectancy-Value Theory also offers explanatory power for these results. Resilient students, who tend to assign more value and utility to their learning tasks, are more likely to exert effort and maintain engagement in learning activities (Rasyid et al., 2023). PBL fosters this valuation by integrating real-world relevance into mathematical problems, thereby making abstract concepts more meaningful and increasing task value perception. As students experience success in solving such problems, their sense of competence and interest grows, reinforcing both effort and academic performance.

Moreover, Self-Determination Theory emphasizes the importance of autonomy, competence, and relatedness in cultivating intrinsic motivation and emotional resilience (Himmelberger et al., 2024; Maulana et al., 2024). PBL environments, characterized by student-driven inquiry and peer collaboration, naturally support these three psychological needs. Students in the experimental group, especially those with high resilience (as indicated by their detailed and multi-step responses in Figures 3 and 4), demonstrated the motivational profile consistent with Self-Determination Theory: intrinsically motivated learners capable of self-regulation and adaptive behavior.

The effectiveness of PBL in nurturing resilience and critical thinking is also evident in the reported large effect sizes (Cohen's d = 2.51 for critical thinking and 2.35 for resilience in Table 6). These values far exceed conventional thresholds for educational significance (Hatch et al., 2022), suggesting that the intervention produced not only statistically significant but also educationally meaningful outcomes. This affirms findings from previous meta-analyses which emphasize the robustness of PBL across grade levels and content areas (Kusuma & Busyairi, 2023; Suparman et al., 2021).

However, not all outcomes were uniformly positive. As shown in Figure 5, students with low resilience failed to demonstrate substantial progress in critical thinking, despite being exposed to PBL. This finding mirrors O'Brien et al. (2020), who argue that while PBL may stimulate cognitive engagement, it does not necessarily guarantee emotional persistence or coping adaptability in all learners. The variability in response to PBL may stem from differences in students' baseline resilience, prior learning experiences, or the emotional climate of the classroom (S. Lee et al., 2024; Lindsay & Morgan, 2021).

Furthermore, contextual factors such as the complexity of mathematical problems, the instructor's ability to facilitate inquiry-based learning, and the availability of peer support can significantly influence how students engage with PBL (Shimizu et al., 2021; Xu et al., 2025). For instance, PBL may need to be supplemented with explicit resilience training or emotional scaffolding for students who exhibit avoidance behaviors or negative emotional responses to failure, as identified in the qualitative analysis of student responses.

Taken together, these findings underscore the importance of an integrated instructional approach that considers both cognitive tasks and the emotional readiness of learners. While

PBL is highly effective for many students, its impact is mediated by a complex interplay of psychological and contextual factors. Thus, educators should be encouraged to adopt differentiated PBL strategies, incorporating formative assessments and resilience-building practices to maximize learning outcomes for diverse learners.

This discussion also highlights the necessity for future research to employ longitudinal and mixed-method designs that capture the dynamic evolution of resilience and cognitive skills over time. Examining how students' motivational profiles and emotional responses develop throughout extended PBL engagement can offer deeper insights into the mechanisms through which affective-cognitive alignment supports academic success.

This study affirms that the integration of PBL with a focus on emotional and psychological dimensions of learning yields significant improvements in both mathematical resilience and critical thinking. Such integration is essential in preparing students not only to excel academically but also to persist and thrive amidst the inherent challenges of learning mathematics. Educational stakeholders are thus urged to design and implement curricula that prioritize both intellectual rigor and emotional resilience, ensuring holistic development of learners in the elementary education context.

CONCLUSION

The conclusion describes the answer to the hypothesis and / or the purpose of the research or scientific findings obtained. Conclusions do not contain repetitions of the results and discussion, but rather summarize the findings as expected in the objectives or hypotheses. Mathematics learning with a model approachproblem based learning shows a big impact on students' critical thinking skills in mathematics, and this form shows a positive relationship. While students in the class are dominated by high mathematical resilience. Therefore, students with mathematics learning using the problem based learning model have better mathematical critical thinking skills than students with conventional mathematics learning. While in the class, students are dominated by resilience. Based on Wright Maps, high mathematical resilience is more common in students who learn using the problem based learning model. Meanwhile, low resilience is more often found in students who follow conventional learning. This shows that students who learn using the problem based learning model are more involved and enthusiastic in the learning process compared to students who follow conventional learning. Based on the findings of the research that has been carried out, educators can use the problem based learning method.

RECOMMENDATION

Based on the results of the research that has been conducted, it is suggested that the development of learning tools based on Problem Based Learning (PBL) be carried out more systematically and contextually to improve students' critical thinking skills, while still considering their level of mathematical resilience. Furthermore, researchers can dig deeper into the media used in learning with more different variations and subjects.

ACKNOWLEDGMENT

The authors would like to thank to the elemntary school principal in the South Tangerang area, the class guardians of VA and VB, parents, add fellow comrades who have assited and prayed for this research to run smoothly.

REFERENCES

Alyani, F., & Putri, N. D. S. (2022). Students’ Mathematical Critical Thinking Using Geogebra Software Based on Adversity Quotient. *Jurnal Pendidikan Dan Pengajaran*, *55*(3), 562–575. https://doi.org/10.23887/jpp.v55i3.47491

Astuti, L., Mayasari, D., & Setyowati, R. (2023). Pengaruh Pendekatan Steam dengan Model Problem Based Learning (PBL) terhadap Hasil Belajar Kognitif Siswa Pembelajaran IPA

SDN 15 Singkawang. *EDUKASIA: Jurnal Pendidikan Dan Pembelajaran*, *4*(2), 2063–2070. https://doi.org/10.62775/edukasia.v4i2.547

Ata, P. F., Rahmadani, A., & Erika, F. (2023). Implementation of the PBL-STEM Model to Improve Students' Critical Thinking on Reaction Rate Material. *Hydrogen: Jurnal Kependidikan Kimia*, *11*(5), 645. https://doi.org/10.33394/hjkk.v11i5.8609

Avvisati, F., & Borgonovi, F. (2020). Learning Mathematics Problem Solving through Test Practice: a Randomized Field Experiment on a Global Scale. *Educational Psychology Review*, *32*(3), 791–814. https://doi.org/10.1007/s10648-020-09520-6

Dewi, N. N. A. P., & Agustika, D. G. N. S. (2023). The Problem-Based Learning Model in Mathematics Subjects by Controlling the Critical Thinking Ability of Elementary School Students. *Mimbar Ilmu*, *28*(1), 23–31. https://doi.org/10.23887/mi.v28i1.57913

Dewi, Y. S., Sriyono, Tanskanen, K., Alfaruq, M. F., Febriyanti, R. D., Biru, M. M. D. T., Fitriani, A. R., & Auliasani, N. F. (2023). Impact of Yearly Flood Disaster Management during Pandemic COVID-19 based on Mother's Resilience Model Focusing on Family Centred Empowerment to Strengthen Resilience of Villagers in Lamongan during Disaster. *Malaysian Journal of Nursing*, *15*(1), 22–28. https://doi.org/10.31674/mjn.2023.v15i01.003

Dilla, S. C., Hidayat, W., & Rohaeti, E. E. (2018). *Faktor gender dan resiliensi dalam pencapaian kemampuan berpikir kreatif matematis siswa sma*. *2*(1), 129–136.

Faradillah, A., & Febriani, L. (2021). Mathematical Trauma Students' Junior High School Based on Grade and Gender. *Infinity Journal*, *10*(1), 53–68. https://doi.org/10.22460/infinity.v10i1.p53-68

Faradillah, A., & Septiana, C. (2022). Mathematical Resilience: Validity and Reliability With Rasch Model and Spss in Senior High School. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *11*(4), 3545. https://doi.org/10.24127/ajpm.v11i4.5204

Haslberger, M., Schorr, S. G., Strech, D., & Haven, T. (2023). Preclinical efficacy in investigator's brochures: Stakeholders' views on measures to improve completeness and robustness. *British Journal of Clinical Pharmacology*, *89*(1), 340–350. https://doi.org/10.1111/bcp.15503

Hatch, T., Corson, J., & den Berg, S. G. van. (2022). New schools in New York City and Singapore. *Journal of Educational Change*, *23*(2), 199–220. https://doi.org/10.1007/s10833-021-09419-1

Hendriana, H., Rohaeti, E. E., & Sumarmo, U. (2017). *Hard skills dan soft skills matematik siswa* (p. 95). Refika Aditama.

Himmelberger, Z. M., Tibbetts, Y., Barron, K. E., Hulleman, C. S., Harootunian, G., & Speicher, M. R. (2024). How Can a Growth Mindset-Supportive Learning Environment in Medical School Promote Student Well-Being? *Families, Systems and Health*, *42*(3), 343–354. https://doi.org/10.1037/fsh0000915

Jamaluddin, A. Bin, Pratiwi, A. C., Safira, I., & Nurdiyanti, N. (2023). Character, Resilience, and Critical Thinking of Biology Students after the Covid-19 Pandemic: How They are Correlated. *Jurnal Penelitian Pendidikan IPA*, *9*(4), 1585–1592. https://doi.org/10.29303/jppipa.v9i4.1574

Julfianto, M., Suanto, E., & Siregar, S. N. (2022). Developing Problem Based Learning Device to Grow Students' Mathematical Critical Thinking Ability. *Jurnal Gantang*, *7*(2), 173–184. https://doi.org/10.31629/jg.v7i2.5318

Khoshgoftar, Z., Karamali, F., Nasrabadi, M. Z., & Nejad, M. H. (2023). Investigating the Correlations between Problem Solving Ability, Resilience and Academic Burnout of Virtual Medical Education Students Using Structural Equation Modeling. *Psychological Science and Education*, *28*(4), 134–144. https://doi.org/10.17759/pse.2023280408

Kooken, J., Welsh, M. E., McCoach, D. B., Johnston-Wilder, S., & Lee, C. (2016). Development and Validation of the Mathematical Resilience Scale. *Measurement and*

Evaluation in Counseling and Development, *49*(3), 217–242. https://doi.org/10.1177/0748175615596782

Kusuma, A. S., & Busyairi, A. (2023). Relationship between metacognitive skills and critical thinking in elementary science lectures through guided inquiry model. *Jurnal Pijar Mipa*, *18*(5), 727–735. https://doi.org/10.29303/jpm.v18i5.5225

Laswadi, L., Setiawan, M. E., Efyanti, Y., Pentang, J. T., & Taresh, S. M. (2023). Distance Learning Design : A Problem-Based Learning with Flipped Classroom Model through improving student learning outcomes and learning motivation Innovative Distance Learning : Leveraging PBL and the Flipped Classroom to Improve Student Outcomes and Mo. *Jurnal Inovasi Pendidikan IPA*, *9*(2), 216–226.

Lee, C., & Johnston-Wilder, S. (2017). The Construct of Mathematical Resilience. In *Understanding Emotions in Mathematical Thinking and Learning*. Elsevier Inc.

Lee, S., Yoon, J. Y., & Hwang, Y. (2024). Collaborative project-based learning in global health: Enhancing competencies and skills for undergraduate nursing students. *BMC Nursing*, *23*(1), 1–12. https://doi.org/10.1186/s12912-024-02111-8

Lindsay, E. D., & Morgan, J. R. (2021). The CSU engineering model: educating student engineers through PBL, WPL and an online, on demand curriculum. *European Journal of Engineering Education*, *46*(5), 637–661. https://doi.org/10.1080/03043797.2021.1922360

Mardiah, E., Hamdani, A., & Komaro, M. (2022). Penerapan Model Pembelajaran Problem Based Learning Untuk Meningkatkan Hasil Belajar. *Jurnal Pendidikan Dan Profesi Keguruan*, *1*(2), 102. https://doi.org/10.59562/progresif.v1i2.29334

Maulana, M. A., Juhaeriah, Y., & Sugiarti, G. (2024). The Effect of Intrinsic Motivation and Work Discipline on Employee Performance with Organisational Commitment as an Intervening Variable (Descriptive Study at Puskesmas Siwalan Pekalongan Regency. *Saudi Journal of Economics and Finance*, *8*(12), 440–453. https://doi.org/10.36348/sjef.2024.v08i12.006

Merianah, M. (2019). pengaruh kecerdasaan emosional dan adversity quotient terhadap kemampuan pemecahan masalah matematika siswa sdit iqra'1. *Jurnal Pendidikan Matematika Raflesia 4 (1);29-35*.

Mohamoud, A. M. (2024). The Impact of Growth Mindset Interventions on Students' Motivation, Resilience, and Academic Achievement. *Multidisciplinary Journal of Horseed International University (MJHIU)*, *2*(1), 102–125. https://doi.org/10.59336/7adj0850

Molina-Muñoz, D., Contreras-García, J. M., & Molina-Portillo, E. (2023). Does the psychoemotional well-being of Spanish students influence their mathematical literacy? An evidence from PISA 2018. *Frontiers in Psychology*, *14*(June), 1–10. https://doi.org/10.3389/fpsyg.2023.1196529

Nabilah, S., Syamsuri, S., & Pujiastuti, H. (2024). The Influence of Self-Regulation, Resilience, and Family Environment on Mathematics Learning Outcomes of Junior High School Students in Serang City, Indonesia. *International Journal of STEM Education for Sustainability*, *4*(1), 1–23. https://doi.org/10.53889/ijses.v4i1.261

Nanni, E. A., Breidenbach, M., Vernieri, C., Belomestnykh, S., Bhat, P., Nagaitsev, S., Bai, M., Berg, W., Barklow, T., Byrd, J., Dhar, A., Dhuley, R. C., Doss, C., Duris, J., Edelen, A., Emma, C., Frisch, J., Gabriel, A., Gessner, S., … Wootton, K. (2022). *C^3 Demonstration Research and Development Plan*. *Snowmass 2021*. http://arxiv.org/abs/2203.09076

Nusaibah, K. A., Ekayanti, A., Jumadi, J., & Murniati, M. (2024). Unveiling Resilience in Mathematics Education: Exploring the Impact of Age and Gender in Sanggar Bimbingan Rawang, Selangor, Malaysia. *Tadris: Jurnal Keguruan Dan Ilmu Tarbiyah*, *9*(1), 19–30. https://doi.org/10.24042/tadris.v9i1.21586

Pertiwi, A. A., & Rizal, F. (2020). Pengaruh model pembelajaran problem based instruction berbasis collaboration, communication, creativity and critical thinking terhadap hasil belajar rangkaian elektonika. *INVOTEK: Jurnal Inovasi Vokasional Dan Teknologi*, *1*(20), 61–68.

Pitt, C., Norris, K., & Pecl, G. (2024). Informing future directions for climate anxiety interventions: a mixed-method study of professional perspectives. *Journal of Outdoor and Environmental Education*, *27*(1), 209–234. https://doi.org/10.1007/s42322-023-00156-y

Rademacher, A. (2022). The Longitudinal Influence of Self-Regulation on School Performance and Behavior Problems From Preschool to Elementary School. *Journal of Research in Childhood Education*, *36*(1), 112–125. https://doi.org/10.1080/02568543.2020.1847219

Rasyid, M., Suhesty, A., Rahayu, D., Indayani, N. N., & Adhikarapandita, A. (2023). Growth Your Mindset to Increase Resilience in College Students. *Indonesian Journal of Educational Research and Review*, *6*(2), 322–329. https://doi.org/10.23887/ijerr.v6i2.60194

Rosliani, V. D., & Munandar, D. R. (2022). Analisis Kemampuan Berpikir Kritis Matematis Siswa Kelas VII Pada Materi Pecahan. *Jurnal Educatio FKIP UNMA*, *8*(2), 401–409. https://doi.org/10.31949/educatio.v8i2.1968

Sánchez Barroso, G., Gónzalez Domínguez, J., Badilla Murillo, F., Aunión Villa, J., García Sanz Salcedo, J., Carrasco Amador, J. P., & Cañito Lobo, J. L. (2020). Implementación del aprendizaje basado en proyectos a través de la tecnología BIM. *Advances in Building Education*, *4*(2), 34–41.

Sawilowsky, S. S. (2009). Very large and huge effect sizes. *Journal of Modern Applied Statistical Methods*, *8*(2), 597–599. https://doi.org/10.22237/jmasm/1257035100

Septiana, C., & Faradillah, A. (2022). Flipped Classroom Learning: Mathematical Creative Thinking Skills Based on Mathematical Resilience using Augmented Reality. *Jurnal Pendidikan Progresif*, *12*(3), 1218–1231. https://doi.org/10.23960/jpp.v12.i3.202217

Shimizu, I., Matsuyama, Y., Duvivier, R., & van der Vleuten, C. (2021). Contextual attributes to promote positive social interdependence in problem-based learning: a focus group study. *BMC Medical Education*, *21*(1), 1–9. https://doi.org/10.1186/s12909-021-02667-y

Sianturi, A., Sipayung, T. N., & Simorangkir, F. M. A. (2018). “Pengaruh Model Problem Based Learning (PBL) Terhadap Kemampuan Berpikir Kritis Matematis Siswa SMPN 5 Sumbul.” *UNION: Jurnal Ilmiah Pendidikan Matematika 6, No. 1*.

Singkhorn, O., Hamtanon, P., Moonpanane, K., Pitchalard, K., Sunsern, R., Leaungsomnapa, Y., & Phokhwang, C. (2023). Evaluation of a depression care model for the hill tribes: a family and community-based participatory research. *BMC Psychiatry*, *23*(1), 1–8. https://doi.org/10.1186/s12888-023-05058-3

Sumintono, B., & Widhiarso, W. (2014). *Aplikasi Model Rasch untuk Penelitian Ilmu-Ilmu Sosial (edisi revisi)* (Issue November).

Suparman, S., Yohannes, Y., & Arifin, N. (2021). Enhancing Mathematical Problem-Solving Skills of Indonesian Junior High School Students through Problem-Based Learning: a Systematic Review and Meta-Analysis. *Al-Jabar : Jurnal Pendidikan Matematika*, *12*(1), 1–16. https://doi.org/10.24042/ajpm.v12i1.8036

Tambunan, L. O. (2021). Model Pembelajaran Creative Problem Solving Untuk Meningkatkan Kemampuan Penalaran Dan Komunikasi Matematis. *JNPM (Jurnal Nasional Pendidikan Matematika)*, *5*(2), 362. https://doi.org/10.33603/jnpm.v5i2.4630

Xu, Y., Shao, Y., Dong, J., Shi, S., Jiang, C., & Li, Q. (2025). Advancing Problem-Based Learning with Clinical Reasoning for Improved Differential Diagnosis in Medical Education. In *Conference on Human Factors in Computing Systems - Proceedings* . https://doi.org/10.1145/3706598.3713772

Zanthy, L. S. (2018). *Kontribusi Resiliensi Matematis Terhadap Kemampuan Akademik Mahasiswa Pada Mata Kuliah Statistika Matematika*. *7*, 85–94.