Jurnal Pengembangan Pembelajaran Matematika (JPPM)
Volume 7, Issue 1, February 2025
Available online at: https://ejournal.uin-suka.ac.id/tarbiyah/jppm/index
Print ISSN : 2656-0240, Online ISSN : 2655-8750

PROBLEM-BASED LEARNING ON CREATIVE THINKING SKILLS IN PRIMARY EDUCATION

Fitria Khoiru Sidqi [1], *Fatkhul Arifin [2]
[1,2] Pendidikan Guru Madrasah Ibtidaiyah UIN Syarif Hidayatullah Jakarta, Jl. Ir. H Juanda Ciputat, Tangerang Selatan, 15412, Indonesia

Email: fatkhul_arf@uinjkt.ac.id
* Corresponding Author

Received: 13-01-2025	*Revised: 05-03-2025*	*Accepted: 07-03-2025*

ABSTRAK

Model pembelajaran yang kurang tepat digunakan seringkali menjadi salah satu permasalahan sehingga tidak tercapainya konsep yang diajarkan dalam pembelajaran matematika. Pada penelitian ini penulis ingin menganalisis sejauh mana model PBL berpengaruh terhadap kemampuan berpikir kreatif siswa dalam pembelajaran matematika, khususnya pada materi pecahan di sekolah dasar. Pendekatan yang digunakan dalam penelitian ini adalah kuantitatif dengan metode kuasi eksperimen dan menerapkan desain posttest only control design. Dibagi menjadi 2 kelas, yakni kelas eksperimen yang menerapkan Problem Based Learning dibandingkan dan kelas kontrol menggunakan model Discovery Learning. Populasi penelitian terdiri dari 74 siswa, sementara sampel penelitian mencakup 49 siswa kelas IV, dengan 24 siswa di kelas eksperimen (IV B) dan 25 siswa di kelas kontrol (IV C). Pengumpulan data dilakukan melalui tes dan dokumentasi dan dianalisis menggunakan SPSS. Hasil analisis menunjukkan bahwa rata-rata nilai siswa di kelas eksperimen (84,70) lebih tinggi dibandingkan kelas kontrol (71,00), dengan nilai t_hitung (6,887) pada tingkat signifikansi 0,000 (<0,05). Dapat disimpulkan, H0 ditolak dan H1 diterima, yang mengindikasikan bahwa metode pembelajaran yang diterapkan dalam kelas eksperimen berpengaruh secara signifikan dalam meningkatkan hasil belajar dibandingkan metode di kelas kontrol. Pemilihan materi pecahan didasarkan pada kesesuaiannya dengan kurikulum serta peranannya dalam mengembangkan keterampilan berpikir kreatif. Analisis mendalam dilakukan dengan meninjau indikator berpikir kreatif, yakni kelancaran, fleksibilitas, dan orisinalitas, guna memperoleh pemahaman yang lebih spesifik mengenai perkembangan kreativitas siswa.

Kata Kunci: eksperimen pendidikan, *problem based-learning*, kemampuan berpikir kreatif, matematika.

ABSTRACT

An inappropriate learning model is often one of the problems so that the concepts taught in mathematics learning are not achieved. In this study, the author wants to analyze the extent to which the PBL model affects students' creative thinking ability in mathematics learning, especially in fractional materials in Primary schools. The approach used in this study is quantitative with a quasi-experimental method and applies a posttest-only control design. It is divided into 2 classes: an experimental class that applies Problem-Based Learning and a control class using the Discovery Learning model. The study population consisted of 74 students, while the study sample included 49 grade IV students, with 24 students in the experimental class (IV B) and 25 in the control class (IV C). Data collection was carried out through tests and documentation and analyzed using SPSS. The results of the analysis showed that the average score of students in the experimental class (84.70) was higher than that of the control class (71.00), with a score of t-count (6.887) at a significance level of 0.000 (<0.05). It can be concluded that H0 was rejected and H1 was accepted, which indicates that the learning method applied in the experimental class significantly improves learning outcomes compared to the method in the control class. The selection of fractional materials is based on their suitability with the curriculum and their role in developing creative thinking skills. An in-depth analysis was conducted by reviewing indicators of creative thinking, namely fluency, flexibility, and originality, in order to obtain a more specific understanding of the development of students' creativity.

Keywords: educational experiment, problem based-learning, creative thinking ability, mathematics.

How to cite

Sidqia, F. K., dan Arifin F. (2021). Problem-Based Learning on Creative Thinking Skills in Basic Mathematics Learning. *Jurnal Pengembangan Pembelajaran Matematika*, 7(1) 65-74. https://doi.org/10.14421/jppm.2025.71.65-74

INTRODUCTION

Mathematics is one of the disciplines that is the basis for technology development. The role of mathematics is crucial in various fields and contributes to improving students' cognitive skills. The current development of information and communication technology is largely supported by advances in mathematics in algebra, number theory, probability theory, analysis, and discrete mathematics. Students' understanding of mathematics early on is very important to master and advance technology. (Al Said et al., 2019; Astuti et al., 2018).

Etymologically, mathematics can be defined as knowledge acquired through reasoning and logical thinking. It emphasizes logical reasoning (ratio) rather than results derived from experiments or observations. Mathematics is developed through human intellectual thought and is closely related to ideas, processes, and logical conclusions (Rahmah, 2015). According to Kline, mathematics is not an independent or self-contained discipline. Instead, its purpose is to support humans in answering various problems connected to social, economic, and natural life. Mathematics does not exist in isolation but functions as a fundamental tool that enables individuals to understand and address real-world challenges (Abu Bakar et al., 2019). In other words, mathematics is a science that specifically studies the concept of numbers and how to perform calculation operations using numbers, as well as applying these concepts and calculations to solve problems related to numbers (Abu Bakar et al., 2019).

Developing creative thinking skills is a key focus in mathematics learning. Mathematics instruction should be intentionally structured to foster students' creative thinking abilities. The enhancement of creative thinking skills should be accompanied by developing appropriate evaluation and measurement methods. Moreover, Torrance defines creativity as a process that involves identifying a problem, exploring potential solutions, formulating hypotheses, testing and assessing those hypotheses, and sharing the outcomes with others. (Maryati, 2021). According to Liu, the ability to think creatively is a unique cognitive process for solving problems (Liu et al., 2019). This process allows a person to use his intelligence in a special way to achieve a certain goal. The essence of this ability is a person's skill to produce original ideas or solutions different from what others generally produce. In other words, creative thinking allows individuals to create something new and unique that reflects their thinking and is different from what already exists or what others are used to thinking (Nehe et al., n.d.; Suardipa, 2019).

Creative thinking is very important for students. These skills help them generate innovative ideas, solve problems uniquely, and see concepts from different perspectives. Creative thinking increases motivation to learn and prepare for the future. It also encourages independent learning and self-expression. Developing these abilities enhances academic achievement and equips students with important skills for long-term achievement in an ever-changing world. According to Hayati & Marliani, Creative thinking is the capability to generate novel and distinct ideas beyond what already exists (Hayati & Marliani, 2018). This ability includes finding innovative solutions to solve problems and designing effective strategies to face various challenges (Hidayah et al., 2021).

A person is said to have the ability to think creatively if they have identified and understood the key indicators of the skill. According to Johnson, creative thinking also demands persistence, self-discipline, and focused attention (Barak & Doppelt, n.d.; Darwanto, 2019; Suardipa, 2019). Sumarmo et al. (2012) identify several key indicators of creative thinking. The first indicator is fluency, which manifests in an individual's capacity to generate multiple ideas, solutions, approaches, or recommendations when addressing problems or responding to questions. The second indicator is cognitive flexibility, characterized by the ability to produce varied ideas, alternative responses, or questions and the skill to view problems from multiple angles and adjust strategies or perspectives as required. Originality is the third aspect, which is characterized by the ability to produce new and unique expressions, design unusual methods, and create unconventional combinations of elements. The third indicator is elaboration, characterized by the skill to provide detailed descriptions of objects, concepts, or situations, making them richer, clearer, and more engaging (Fahrudin et al., 2018).

The creative thinking indicators in this study are based on several essential aspects, including fluency, flexibility, originality, and elaboration in solving mathematical problems. In the context of fractions, these indicators can be seen in students' ability to propose various ways to solve fraction problems, provide diverse alternative answers, and develop new ideas or strategies for understanding fraction concepts. Therefore, this study aims to evaluate the effectiveness of the PBL model in developing students' creative thinking skills in understanding and solving fractions-related problems.

PBL is one of the widely recognized learning methods in the world of modern education. PBL utilizes real-world challenges as a basis for learning, encouraging students to think critically, develop problem-solving skills and improve students' ability to work independently and collaboratively (Al Said et al., 2019; Yew & Goh, 2016). This method supports higher-order thinking skills and strengthens a deep understanding of the subject matter. Rendering to Barrows & Tamblyn (1980), PBL is a strategy that combines the curriculum with the learning process. Learning using the PBL model is designed with problems that require students to have knowledge, skills in solving problems, independent learning and the ability to participate in teams (Hartata, 2020).

The results of research in Indonesia show that mathematics learning still faces various problems. Some common obstacles include low math proficiency ratings in international events such as *the Program For International Student Assessment* (PISA), low math scores in final exams compared to other subjects, misconceptions often experienced by students, and lack of interest in learning mathematics. Based on PISA 2022 data, the mathematics scores of Indonesian students decreased by 13 points when compared to the results of PISA 2018. Indonesian students in mathematics reached a score of 366, from the score in the previous edition of 379, while the OECD average was 472. Meanwhile, the math ability rating is at 70. The data showed a gradual decline in students' mathematical ability. Students' understanding and application of mathematical concepts occasionally decrease (Im & Jitendra, 2020; Schleicher, 2022).

Based on preliminary observation, researchers discovered that some students exhibited low creative thinking abilities in mathematics learning. This is evidenced by causative factors that cause them to have low creative thinking skills in mathematics learning. Several contributing factors include the less-than-optimal implementation of learning methods or models during the teaching process. Consequently, students have difficulty building enthusiasm for learning, tend to be passive, and lack creativity during learning.

The syntactic structure in PBL is an essential framework for applying this model optimally in the classroom. PBL phases are structured to promote student-centred learning, foster critical and creative thinking, and enhance problem-solving abilities. According to Rusman, the PBL model includes several phases, namely providing problems to students, organizing problems as part of learning, guiding individual and group investigations, facilitating the development and presentation of student work, and analyzing and evaluating the problem-solving process (Yuafian & Astuti, 2020).

Several prior studies have established that implementing the PBL model can improve students' creative thinking abilities in mathematics education. Shinta Wulandari et al., in their study, discovered that the PBL model significantly influenced students' creative thinking abilities in comprehending mathematics learning among fifth-grade Primary school students. Moreover, it is concluded that implementing PBL positively influences the creative thinking skills of fifth-grade Primary school students in grasping mathematical concepts (Arifin & Herman, 2018; Wulandari et al., 2023).

This study analyzes the effect of applying PBL on developing students' creative thinking skills in mathematics learning at the Primary school level. This aspect is rarely explored because most PBL research is conducted in higher education. This research can yield new insights into how to stimulate creativity in subjects often considered rigid and innovative strategies for integrating PBL in Primary mathematics curricula. The findings may contribute to shaping teaching strategies and educational policies, particularly in enhancing students' creative thinking abilities from an early stage.

The PBL model has been proven to have a positive impact. However, its application in improving the creative thinking skills of Primary school students, exclusively in mathematics learning, has not been studied in depth. One way to address these gaps is to apply the PBL model, so that students can understand concepts more deeply through exploration, real-world-based projects, and problem-solving. The novelty of this research lies in its focus on the primary school level, which distinguishes it from previous studies that were mostly conducted at higher education levels. The findings of this study are expected to serve as a reference for developing innovative and effective learning strategies to foster students' creativity from an early age.

METHOD

The approach in this study is quantitative with a quasi-experimental method. The posttest-only control group design was used to analyze the influence of the PBL model on students' creative thinking skills in mathematics learning. The population consisted of 74 Grade IV students, from which a sample of 49 students was selected. The students were split into two groups: the experimental class (IV B), with 24 students, who were taught using the PBL model, and the control class (IV C), with 25 students, who received instruction through the Discovery Learning model.

The intervention was conducted across multiple sessions, where each session in the experimental group followed the PBL stages, including problem presentation, student group organization, facilitating investigation and problem-solving, presenting solutions through group discussions, and reflecting on the overall learning process. Meanwhile, the control group engaged in the Discovery Learning model, emphasising individual exploration and teacher-guided concept discovery. Observations were conducted during the sessions to ensure that each learning model was implemented consistently according to the research framework.

The research instruments comprised post-tests to assess students' creative thinking abilities, observations to evaluate the learning procedure in the classroom, and documentation as supporting data, including lesson plans and student worksheets. Data analysis was performed using an independent t-test to compare the post-test scores between the experimental and control groups. This analysis aimed to determine whether the PBL model had a significantly greater impact on students' creative thinking skills than the Discovery Learning model. This detailed method ensured a comprehensive understanding of the differences in outcomes between the two learning approaches. The following is the research design carried out in the research:

Table 1. Research Design

Group	Treatment	Measurement
Experimental Group	Problem-Based Learning (PBL)	Posttest
Control Group	Discovery Learning	Posttest

This table displays the posttest-only control group design, part of the quasi-experimental method. By comparing the results of the two groups after being given the intervention, the effectiveness of the PBL model compared to Discovery Learning in improving students' creative thinking skills can be evaluated.

RESULTS

This study involved 74 grade 4 Primary school students divided into two groups: experimental and control. The research was conducted over four sessions for each class, with the experimental class implementing the PBL model and the control class utilizing the Discovery Learning model. The learning process followed the respective syntax of both models, and a post-test was administered at the end of the process to evaluate each approach's impact. Our initial hypothesis states: H_0 – The application of the PBL model has no significant effect, while H_1 – The application of the PBL model has a significant effect.

To ensure that the collected data meets the criteria for parametric analysis, a normality test is carried out using the Shapiro-Wilk method. The results of this test are presented in the following table:

Table 2. Normality Test

Variable	Kelas	*Shapiro-Wilk*			Kesimpulan
		Statistic	Df	Sig.	
PBL Learning Model	Experiment	0,949	24	0,259	Normally distributed
Model Discovery Learning	Control	0,960	25	0,407	Normally distributed

The data above presents the results of the Shapiro-Wilk normality test, which determines whether the data from the experimental and distributed control groups is normal. Based on the results, the significance value (Sig.) was 0.259 for the experimental group and 0.407 for the control group. Both values exceeded the standard significance threshold of 0.05, so it can be concluded that the two groups are normally distributed. Therefore, the normality assumption is met, indicating that the data is valid and can be further analysed using parametric statistical tests.

Furthermore, a homogeneity test was carried out using the Levene test, to find out whether the variance of the data between the experimental group and the control group was homogeneous. It is presented in the following table:

Table 3. Homogeneity Test

Variable	*Levene Statistic*	df1	df2	Sig.	Conclusion
PBL Learning Model	0,810	1	47	0,373	Homogen

The table above presents the results of the Levene Test regarding variance homogeneity, which is used to determine whether the variance between the experimental and control groups is comparable. The analysis results show that the Levene Statistics is worth 0.810 with degrees of freedom (df1 = 1, df2 = 47) and significance values (Sig.) of 0.373. Since the significance value is greater than the standard limit of 0.05, it can be concluded that the variance between the groups is homogeneous. This confirms that the assumption of variance homogeneity is satisfied, allowing the data to be analyzed further using parametric statistical tests.

After meeting the assumptions of normality and homogeneity, a hypothesis test was carried out using the Independent Samples Test to compare the post-test results between the experimental and control groups. The results of the hypothesis test are presented in the following table:

Table 4. Independent Samples Test

		Lavene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tiled)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Posttest	Equal variances assumed	0,810	0,373	6,887	47	0,000	12,0708	1,8979	9,2527	16,8890

The table above displays the results of the Independent Sample t-test, which compares post-test scores between the experimental and control groups. The Levene Test for Variance Equality results showed a significance value (Sig.) of 0.373, confirming that the variance equality assumption had been met. The t-test results showed a t-value of 6.887 with degrees of freedom (df) = 47 and significance values (Sig. 2-tailed) = 0.000, which was smaller than the significance limit of 0.05. This indicates a statistically significant difference in the mean post-test score between the two groups.

The mean difference is 12.0708, with a standard error of 1.8979. The 95% confidence interval for this difference ranges from 9.2527 to 16.8890, which confirms that the difference is statistically significant and has substantive meaning. These results indicate that the PBL model's experimental group achieved a higher post-test score than the control group applying the Discovery Learning model. These findings confirm that PBL effectively develops students' creative thinking skills.

The analysis results confirmed that the PBL model positively and significantly impacted students' creative thinking skills compared to the Discovery Learning model. The average difference of 12.0708 shows the significant influence of PBL in improving students' creative thinking skills.

DISCUSSION

The study's results revealed that applying the PBL model significantly improved students' creative thinking skills more than the Discovery Learning model. This evidence can be seen from the average post-test score of the experimental class (84.70), which is higher than that of the control class (71.00). In addition, the statistical test results support this finding, where the value of the t count (6.887) is greater than that of the t table (2.013) at a significance level of 0.05. Thus, the null hypothesis (H_0) is rejected, which indicates that applying the PBL model significantly influences students' creative thinking ability.

According to Barrows and Tamblyn, the PBL model is an instructional approach focusing on students independently solving problems through a structured process, including problem identification, information gathering, data analysis, and solution development (Barrows & Tamblyn, 1980). This process stimulates students to think critically and creatively, as they must understand problems from multiple perspectives and develop innovative solutions. Thus, applying PBL encourages meaningful learning (constructivist learning) according to Piaget's theory of constructivism, where students actively build knowledge through experience.

Furthermore, according to Guilford, creative thinking encompasses four key dimensions: fluency, flexibility, originality, and elaboration (Guilford, 1967). The PBL model effectively trains these dimensions because students are encouraged to develop various ideas, choose the most effective solutions, and outline their plans in detail.

Comparisons with Discovery Learning models also provide additional insights. Although Discovery Learning is also an active learning method that involves students in discovering concepts independently (Bruner, 1961), This model tends to focus more on exploring predetermined concepts, so the space for creative thinking may not be as large as in PBL. In PBL, students face complex, real-world problems requiring more creativity.

These results are consistent with Hmelo's research, which revealed that PBL significantly improves higher-order thinking skills, including creative thinking, by engaging students in deep and contextual learning (Hmelo-Silver, 2004). Moreover, a study by Yew and Goh also confirms that PBL positively contributes to the enhancement of creative skills, particularly in subjects that involve complex problem-solving, such as mathematics (Yew & Goh, 2016).

Practically, the results of this study show that the application of PBL can be an effective strategy for improving the quality of mathematics learning in Primary schools, especially in developing students' creative thinking skills (Nehe et al., n.d.). Teachers are advised to design problem-based learning scenarios that are relevant to the context of students' lives so that students are more motivated and actively involved in the learning process (Al Said et al., 2019).

This research demonstrates that applying PBL significantly improves students' creative thinking abilities in Primary school mathematics education. These findings align with the research of Hmelo-Silver (2004), which found that PBL effectively fosters higher-order thinking skills by promoting deeper and more contextual learning experiences for students. Additionally, the study by Yew and Goh (2016) also demonstrated that PBL positively impacts students' creativity, particularly in subjects that require complex problem-solving, such as mathematics. However, the primary uniqueness of this research is its emphasis on primary school education, particularly in mathematics instruction, which focuses on fraction concepts. Previous research on PBL has predominantly been conducted at higher education levels, such as secondary schools or universities. Therefore, this study makes a new contribution by proving that PBL is effective at higher education levels and can be successfully implemented in primary schools to develop students' creative thinking skills. These results offer new insights into how PBL can be adapted for basic mathematics learning and serve as a valuable reference for teachers in designing more innovative teaching strategies to enhance students' creativity early on.

CONCLUSION

The study results show that the Problem-Based Learning (PBL) model significantly improves students' creative thinking skills in mathematics learning in elementary schools. The experimental group that applied PBL obtained a higher average post-test (84.70) than the control group that used Discovery Learning (71.00). The statistical test results with a t-value of 6.887 at a significance level of 0.05 confirmed a statistically significant difference. In addition, the normality and homogeneity tests showed that the data met the parametric analysis assumptions so that the study results could be considered valid and reliable.

These findings reinforce previous research that confirms that PBL encourages students to think critically, creatively, and innovatively through real-world context-based problem-solving. Therefore, applying PBL is recommended as an effective learning strategy to improve students' creative thinking skills in mathematics. Further research can be conducted to explore the effectiveness of this model at higher education levels or in other subjects.

These findings align with previous theories and research that state that PBL encourages students to think critically, creatively, and innovatively through real-life problem-solving. Therefore, the PBL model is suggested as an effective learning method to improve students' creative thinking skills, especially in mathematics subjects that require problem-solving skills.

ACKNOWLEDGMENTS

With gratitude, I would like to sincerely thank the Head of the PGMI Study Program (Kaprodi) and all PGMI UIN Jakarta lecturers for the support, guidance, and motivation given during this learning and research process. Without the direction and support of all lecturers, I could not complete this task and responsibility properly.

REFERENCES

Al Said, R. S., Du, X., Al Khatib, H. A. H. M., Romanowski, M. H., & Barham, A. I. I. (2019). Math teachers' beliefs, practices, and belief change in implementing problem based learning in Qatari primary governmental school. *Eurasia Journal of Mathematics, Science and Technology Education*, *15*(5), em1710. https://doi.org/10.29333/EJMSTE/105849

Arifin, F., & Herman, T. (2018). Pengaruh pembelajaran e-learning model web centric course terhadap pemahaman konsep dan kemandirian belajar matematika siswa. *Jurnal Pendidikan Matematika*, *12*(2), 1–12. https://doi.org/10.22342/JPM.12.2.4152.1-12

Astuti, R., Yetri, Y., & Anggraini, W. (2018). Pengaruh model pembelajaran auditory intellectually repetition (AIR) terhadap kemampuan berpikir kritis siswa pada materi kemagnetan kelas. *Indonesian Journal Of*, *01*(2), 1–12.

Bakar, S. A., Ayub, A. F. M., Gopal, K., & Salim, N. R. (2019). The influence of students' beliefs on mathematical problem solving towards mathematics achievement among Malaysian matriculation students. *Universal Journal of Educational Research*, *7*(10), 2243–2247. https://doi.org/10.13189/ujer.2019.071025

Barak, M., & Doppelt, Y. (n.d.). *Using Portfolios to Enhance Creative Thinking*.

Barrows, H. S., & Tamblyn, R. M. (1980). P*roblem-based learning; an approach to medical education*.

Bruner, J. S. (1961). T*he process of education*. Harvard University Press.

Darwanto. (2019). K*emampuan berpikir kreatif matematis (pengertian dan indikatornya)*. *9*(2), 20–26.

Fahrudin, A. G., Zuliana, E., & Bintoro, H. S. (2018). Peningkatan pemahaman konsep matematika melalui realistic mathematic education berbantu alat peraga bongpas. *ANARGYA: Jurnal Ilmiah Pendidikan Matematika*, *1*(1), 14–20. https://doi.org/10.24176/anargya.v1i1.2280

Guilford, J. P. (1967). *The natur of human intelligent*. McGraw-Hill Education.

Hartata, R. (2020). Model pembelajaran problem-based learning (PBL) sebagai upaya meningkatkan motivasi dan prestasi belajar sejarah (peminatan). *Keraton: Journal of History Education and Culture*, *1*(2), 1–4.

Hayati, N., & Marliani, N. (2018). Kemampuan berpikir kreatif pada pembelajaran matematika dengan menggunakan metode drill. *Journal Of Mathematics Science and Education*, *1*(1), 87–101. https://doi.org/10.31540/jmse.v1i1.143

Hidayah, N. C., Ulya, H., & Masfuah, S. (2021). Analisis kemampuan berpikir kreatif siswa sekolah dasar berdasarkan tingkat kemampuan matematis. *Jurnal Educatio FKIP UNMA*, *7*(4), 1368–1377. https://doi.org/10.31949/educatio.v7i4.1366

Hmelo-Silver, C. E. (2004). Problem-based learning: what and how do students learn? *Educational Psychology Review*, *16*(3), 235–266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3

Im, S., & Jitendra, A. K. (2020). Analysis of proportional reasoning and misconceptions among students with mathematical learning disabilities. *The Journal of Mathematical Behavior*, *57*, 100753. https://doi.org/10.1016/j.jmathb.2019.100753

Liu, Q., Tong, S., Liu, C., Zhao, H., Chen, E., Ma, H., & Wang, S. (2019). Exploiting cognitive structure for adaptive learning. *Proceedings of the 25th ACM SIGKDD International Conference on Knowledge Discovery & Data Mining*, 627–635. https://doi.org/10.1145/3292500.3330922

Maryati, I. (2021). Analisis kemampuan berpikir kreatif matematis siswa sekolah menengah atas dalam materi aljabar. *PYTHAGORAS: Jurnal Pendidikan Matematika*, *16*(2), 253–265.

Nehe, M., Surya, E., & Syahputra, E. (2017). Creative thinking ability to solving equation and non-equation of linear single variable in VII grade junior high school. *Journal of advance research and Innovative Ideas in Education*, 3(1).

Rahmah, A. (2015). Digital literacy learning system for indonesian citizen. *Procedia Computer Science*, *72*, 94–101. https://doi.org/10.1016/j.procs.2015.12.109

Schleicher, A. (2022). *Programme for international student assessment PISA 2022 insights and interpretations*.

Suardipa, I. P. (2019). Kajian creative thinking matematis dalam inovasi pembelajaran. *Purwadita: Jurnal Agama Dan Budaya*, *3*(2), 15–22.

Sumarmo, U., Hidayat, W., Zukarnaen, R., Hamidah, & Sariningsih, R. (2012). Kemampuan Dan Disposisi Berpikir Logis, Kritis, Dan Kreatif Matematik. Jurnal Pengajaran MIPA, 17(1), 10–27. https://ejournal.upi.edu/index.php/jpmipa/article/view/36048

Wulandari, S., Misdalina, & Tanzimah. (2023). Pengaruh model problem based learning terhadap kemampuan berpikir kreatif peserta didik dalam memahami pembelajaran matematika kelas V SDN 33 Palembang. *Journal on Education*, *06*(01), 6155–6163.

Yew, E. H. J., & Goh, K. (2016). Problem-based learning: an overview of its process and impact on learning. *Health Professions Education*, *2*(2), 75–79. https://doi.org/10.1016/j.hpe.2016.01.004

Yuafian, R., & Astuti, S. (2020). Peningkatan hasil belajar siswa menggunakan model pembelajaran problem based learning (PBL). *JRPD (Jurnal Riset Pendidikan Dasar)*, *3*(1), 17–24. https://doi.org/10.26618/jrpd.v3i1.3216