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Enhancing Mathematical Problem-Solving Ability in Statistics through Problem-Based Learning: Evidence Across Polya's Stages

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Abstract
This study examined changes in junior high school students' mathematical problem-solving performance in Statistics following the implementation of Problem-Based Learning (PBL), with particular attention to Polya's four problem-solving stages. A quantitative pre-experimental approach using a One-Group Pretest–Posttest design was conducted with 31 eighth-grade students selected through purposive sampling. Data were collected using a mathematical problem-solving essay test and analyzed using descriptive statistics, normalized gain (N-Gain), and a paired-samples t-test. The results showed a statistically significant difference between students' pretest and posttest performance ($t(30) = 15.734$, $p < .001$). The mean score increased from 45.16 to 78.06, with a mean N-Gain of 0.59, indicating moderate improvement, while classical mastery increased from 9.68% to 83.87%. Across Polya's stages, the greatest improvement occurred in carrying out the plan (48.39 percentage points), followed by devising a plan (45.16 percentage points). Although looking back also improved, it remained the least developed stage, with 38.71% of students demonstrating achievement at posttest. These findings indicate that students' mathematical problem-solving performance improved following PBL implementation, while the relatively low achievement in looking back highlights the need for explicit reflection and metacognitive scaffolding within PBL-based mathematics learning.
Keywords: Problem-Based Learning, mathematical problem-solving ability, Polya's stages, statistics, mathematics education

Introduction

Mathematics plays a fundamental role in developing logical reasoning, critical thinking, creativity, and problem-solving skills essential for addressing real-world challenges (OECD, 2023). Through mathematics learning, students are expected not only to acquire computational proficiency but also to reason systematically, make informed decisions, and apply mathematical concepts in various situations. Consequently, mathematics education increasingly emphasizes higher-order thinking skills that enable learners to understand, analyze, and solve complex problems beyond routine classroom exercises. In line with this perspective, the Indonesian education system emphasizes students' reasoning and problem-solving abilities as integral components of meaningful mathematics learning (Kemendikbudristek, 2022).

The importance of problem-solving ability is also reflected in contemporary educational frameworks that identify problem solving as a key competency required in the twenty-first century. In mathematics education, problem solving is regarded not only as a learning objective but also as a means through which students construct mathematical understanding and develop productive ways of thinking (NCTM, 2020; OECD, 2023). However, curricular emphasis on problem solving does not necessarily ensure that students develop this ability effectively. Mathematical problem solving requires students to coordinate conceptual understanding, strategic reasoning, and appropriate procedures, particularly when addressing non-routine and contextual problems. Students may know mathematical procedures but still experience difficulties in identifying relevant information, selecting appropriate strategies, and evaluating the reasonableness of their solutions. These difficulties indicate a gap between curricular expectations and students' actual problem-solving performance and highlight the need for instructional approaches that explicitly engage students in meaningful problem-solving processes.

Despite its recognized importance, mathematical problem solving remains a significant challenge in Indonesia. PISA 2022 results indicate that only 18% of Indonesian students attained at least Level 2 proficiency in mathematics, compared with 69% on average across OECD countries (OECD, 2023). At this level, students are expected to recognize and interpret how a simple situation can be represented mathematically, whereas higher proficiency levels require students to model complex situations and select, compare, and evaluate appropriate problem-solving strategies. These results suggest difficulties in applying mathematical knowledge to contextual situations. Although PISA and Polya's framework represent different assessment and theoretical perspectives, the processes emphasized in PISA are conceptually related to Polya's stages: mathematical representation relates to understanding the problem and devising a plan, applying mathematical concepts and procedures relates to carrying out the plan, and interpreting and evaluating outcomes relates to looking back (OECD, 2023; Polya, 1945). Thus, the difficulties identified by PISA highlight the need for instructional approaches that strengthen students' problem-solving processes from understanding and planning through implementation and evaluation.

The gap between curricular expectations and students' performance highlights the need for instructional approaches that actively engage learners in meaningful mathematical activities. Traditional teacher-centered instruction may emphasize procedural knowledge and routine exercises, limiting opportunities for students to develop deeper conceptual understanding and independent problem-solving skills. Problem-Based Learning (PBL) offers a relevant instructional framework because it engages students in authentic problems through inquiry, self-directed learning, and collaborative knowledge construction (Barrows, 1996; Hmelo-Silver, 2004; Savery, 2006). PBL positions students as active participants who investigate problems, develop explanations, and apply knowledge to construct solutions rather than primarily receiving information through direct instruction (Savery, 2006). These characteristics provide opportunities for processes conceptually aligned with Polya's problem-solving stages: identifying and understanding a problem relates to understanding the problem, exploring approaches and developing strategies corresponds to devising a plan, implementing solutions relates to carrying out the plan, and presenting, evaluating, and reflecting on solutions provide opportunities related to looking back (Polya, 1945). This alignment provides a theoretical basis for examining how PBL may support students' mathematical problem-solving ability.

A growing body of research has reported positive outcomes associated with PBL in mathematics education. Previous studies have shown that PBL can support students' mathematical understanding, critical thinking, communication, and problem-solving abilities. Faoziyah (2022) reported improvements in students' mathematical problem-solving performance following PBL-based mathematics learning. Similarly, Sari et al. (2022) found that PBL contributed positively to students' mathematical thinking processes. These findings suggest that PBL is a promising instructional approach for addressing challenges in mathematical problem solving.

Among the various topics taught in junior secondary mathematics, Statistics requires analytical and problem-solving skills. Statistics involves not only numerical calculations but also collecting, organizing, representing, analyzing, and interpreting data to draw meaningful conclusions. Students therefore need to understand contextual information, select appropriate strategies, interpret results, and evaluate the reasonableness of their conclusions. These characteristics make Statistics a relevant context for examining students' mathematical problem-solving ability.

However, students often experience difficulties in learning Statistics. They may struggle to interpret data, identify relevant information, and apply statistical concepts to contextual problems. Susanti and Arifin (2022) found that junior secondary students frequently experienced challenges in developing productive mathematical thinking habits during Statistics learning. Such difficulties indicate the need for learning experiences that promote active engagement with data and encourage students to construct understanding through exploration and inquiry. Instructional approaches emphasizing authentic problem solving may therefore be relevant for supporting learning in Statistics.

The characteristics of PBL align with the nature of Statistics learning. Through contextual problems, PBL encourages students to investigate data, discuss interpretations, formulate solution strategies, and justify conclusions. Collaborative discussions also provide opportunities to exchange ideas, evaluate alternative perspectives, and refine reasoning. Thus, PBL may create meaningful opportunities for students to develop mathematical problem-solving competence in Statistics.

While numerous studies have examined the effectiveness of PBL in improving mathematical learning outcomes, understanding how students progress through the problem-solving process is also important. Measuring final performance alone may not reveal the cognitive processes underlying problem solving. Examining how students approach problems, develop strategies, implement solutions, and evaluate their work can provide a more comprehensive understanding of their mathematical thinking.

Polya's problem-solving framework offers a relevant perspective for examining these processes. The framework consists of four stages: understanding the problem, devising a plan, carrying out the plan, and looking back (Polya, 1945). These stages provide a structured representation of activities involved in mathematical problem solving and have been widely used in mathematics education research. Research has shown that instructional approaches incorporating Polya's stages can improve students' ability to solve mathematical problems, particularly word problems (Apryanti et al., 2017). Polya's framework therefore provides a systematic lens for examining how students' mathematical problem-solving ability develops through PBL.

Previous studies have demonstrated the potential of PBL to support students' mathematical competencies, although they differ in learning outcomes, contexts, and methodological approaches. Faoziyah et al. (2022) reported increased mathematical problem-solving achievement following PBL implementation in trigonometry learning at the secondary vocational school level, with the proportion of students achieving the minimum mastery criterion increasing from 37.5% in the first cycle to 78% in the second cycle. Sari et al. (2022) found that PBL significantly influenced mathematical creative thinking ability, although their study did not directly examine mathematical problem-solving ability. More recently, Soliha and Amidi (2025) reported that PBL combined with differentiated instruction and GeoGebra supported mathematical problem-solving achievement among junior secondary students. Their study incorporated indicators corresponding to Polya's four stages, but focused primarily on overall achievement and mastery rather than the development of each problem-solving stage. Meanwhile, Susanti and Arifin (2022) examined mathematical habits of mind in Statistics problem solving and found that students were generally not accustomed to metacognitive thinking and recognizing unusual aspects of mathematical situations. Collectively, these studies suggest that PBL can support mathematical competencies and problem-solving achievement, while reflective and metacognitive aspects remain challenging. However, none of the studies reviewed explicitly examines how students' achievement develops across Polya's four problem-solving stages within PBL-based Statistics learning at the junior secondary level.

Although previous research has demonstrated the potential of PBL to improve overall mathematical problem-solving performance, it has not sufficiently explained how students develop across distinct stages of the problem-solving process, particularly in Statistics learning at the junior secondary level. An overall problem-solving score may indicate whether students reach correct solutions but does not reveal which stages constitute their strengths or difficulties. Examining performance across Polya's stages can therefore provide more specific information about how PBL supports students' problem-solving processes and where additional instructional support may be needed. Accordingly, the novelty of the present study lies in its stage-specific analysis of students' mathematical problem-solving ability following PBL implementation by examining performance across Polya's four stages—understanding the problem, devising a plan, carrying out the plan, and looking back—in junior secondary Statistics learning. This analysis provides empirical evidence regarding which problem-solving stages show greater improvement and which remain challenging after PBL implementation.

Based on the foregoing discussion, the research question addressed in this study is: Is Problem-Based Learning effective in improving students' mathematical problem-solving ability as viewed through Polya's problem-solving stages? Accordingly, this study aims to analyze the effectiveness of PBL in enhancing junior secondary students' mathematical problem-solving ability in Statistics based on Polya's framework. The findings are expected to contribute theoretically and practically by providing empirical evidence regarding the role of PBL in supporting mathematical problem solving and insights for teachers in designing learning activities that foster systematic and reflective problem-solving processes.

A review of previous literature reveals that the effectiveness of PBL has been examined across various educational contexts and outcome measures. Meta-analytic evidence has generally reported positive effects of PBL on students' knowledge and skills

(Dochy et al., 2003), although the magnitude of its effects may vary according to assessment characteristics and specific learning outcomes (Gijbels et al., 2005). Walker and Leary (2009) further showed that PBL outcomes vary across problem types, implementation approaches, disciplines, and assessment levels. Similarly, Strobel and van Barneveld (2009) found that the relative advantages of PBL were particularly evident in longer-term retention and skill development. However, most of this literature evaluates PBL effectiveness at the level of overall learning outcomes or general problem-solving performance rather than examining students' achievement at each stage of the problem-solving process.

Method

This study employed a quantitative approach using a pre-experimental One-Group Pretest–Posttest design (Fraenkel, Wallen, & Hyun, 2019). The study was conducted during the second semester of the 2024/2025 academic year in an eighth-grade class at a public junior high school in Mlati District, Sleman Regency, Indonesia. A total of 31 students participated and were selected through purposive sampling because the class was studying Statistics and the mathematics teacher agreed to participate in the study.

The study began with a pretest to assess students' initial mathematical problem-solving ability. Problem-Based Learning (PBL) was then implemented over three instructional sessions on Statistics. The learning activities followed the PBL syntax and were guided by Polya's problem-solving stages: understanding the problem, devising a plan, carrying out the plan, and looking back. After the intervention, a posttest was administered to assess students' mathematical problem-solving ability.

Data were collected using a mathematical problem-solving essay test consisting of five items developed based on Polya's problem-solving stages. The instrument was validated by two mathematics education experts and demonstrated high reliability, with a Cronbach's Alpha coefficient of 0.87 (George & Mallery, 2003). Documentation was also used to support and verify the implementation of the research procedures.

Data were analyzed using descriptive and inferential statistics. Descriptive statistics included mean scores, standard deviations, minimum and maximum scores, and classical mastery achievement for the pretest and posttest. The effectiveness of PBL was evaluated using normalized gain (N-Gain), hypothesis testing, and descriptive analysis of students' achievement across Polya's problem-solving stages. Before hypothesis testing, the normality of the gain scores was assessed using the Shapiro–Wilk test. When the normality assumption was met, a Paired-Samples t-test was conducted; otherwise, the Wilcoxon Signed-Rank Test was used. Statistical significance was determined at α = 0.05. N-Gain scores were interpreted according to Hake (1998), with values of ≥ 0.70 categorized as high, 0.30–0.69 as moderate, and < 0.30 as low.

Results and Discussion

The effectiveness of Problem-Based Learning (PBL) in supporting students' mathematical problem-solving ability in Statistics was examined using descriptive and inferential analyses. The results are presented in terms of overall learning outcomes and students' achievement across Polya's problem-solving stages.

Table 1. Descriptive Statistics of Pretest, Posttest, and N-Gain Scores (n = 31).

Statistic	Pretest	Posttest	N-Gain
Mean	45.16	78.06	0.59
Standard Deviation	9.24	8.57	0.16
Minimum	30	60	0.33
Maximum	60	95	0.86
Classical Mastery	9.68% (3 students)	83.87% (26 students)	-

Table 1 shows an increase in students' mathematical problem-solving performance following the implementation of PBL. The mean score increased from 45.16 on the pretest to 78.06 on the posttest, while classical mastery increased from 9.68% (3 students) to 83.87% (26 students). The mean N-Gain of 0.59 falls within the moderate category according to Hake (1998), indicating a moderate level of improvement in students' performance. The distribution of students' N-Gain scores is presented in Table 2.

Table 2. Distribution of Students' N-Gain Categories.

Category	Number of Students	Percentage
High	9	29.03%
Moderate	19	61.29%
Low	3	9.68%

As shown in Table 2, most students demonstrated moderate improvement. Nineteen students (61.29%) were categorized as having moderate N-Gain, while nine students (29.03%) achieved a high N-Gain. Only three students (9.68%) were categorized as having low N-Gain. Thus, 90.32% of the students achieved at least a moderate level of gain, indicating that improvement was observed for most participants following the PBL intervention.

The statistical significance of the difference between pretest and posttest scores was examined using a paired-samples t-test, as presented in Table 3.

Table 3. Results of Hypothesis Testing.

Test	Statistics	df	p-value
Paired Sample t-test	15.734	30	0.000

Table 3 shows a statistically significant difference between students' pretest and posttest scores, $t(30) = 15.734$, $p < .001$. Therefore, students' mathematical problem-solving performance was significantly higher after the implementation of PBL than before the intervention. Taken together with the moderate mean N-Gain, these results indicate a meaningful improvement in students' mathematical problem-solving performance following PBL-based instruction.

This finding is consistent with previous research reporting positive outcomes of PBL for mathematical problem solving (Faoziyah et al., 2022). The improvement may be related to the problem-centered characteristics of PBL, which engage students in investigating problems, discussing possible approaches, and constructing solutions collaboratively. Such activities provide opportunities for students to connect mathematical concepts with contextual situations and develop their reasoning during the solution process. This interpretation is consistent with Barrows (1996), who emphasized learning initiated through meaningful problems, and Hmelo-Silver (2004), who highlighted the role of PBL in supporting flexible knowledge, self-directed learning, collaboration, and problem-solving through inquiry-based learning experiences.

To examine how this improvement was reflected in different aspects of problem solving, students' achievement across the four stages of Polya's framework was analyzed.

Table 4. Students' Achievement Across Polya's Problem-Solving Stages.

Polya Stage	Pretest (%)	Posttest (%)	Increase
Understanding the Problem	74.19	87.10	12.91
Devising a Plan	41.94	87.10	45.16
Carrying Out the Plan	22.58	70.97	48.39
Looking Back	3.23	38.71	35.48

Table 4 shows improvement across all four stages of Polya's problem-solving framework. The largest increase occurred in carrying out the plan, which increased by 48.39 percentage points, followed by devising a plan, which increased by 45.16 percentage points. Understanding the problem increased by 12.91 percentage points, while looking back increased by 35.48 percentage points. Despite this improvement, looking back remained the least developed stage in the posttest, with 38.71% of students demonstrating achievement at this stage.

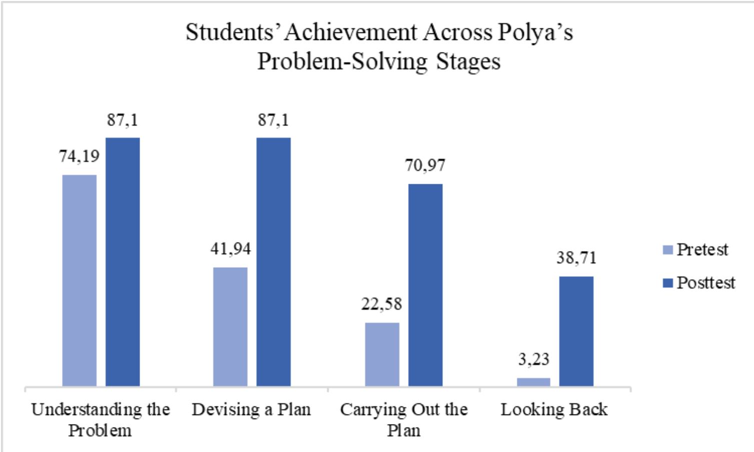

Figure 1. Students' Achievement Across Polya's Problem-Solving Stages

Figure 1 further illustrates the differences in students' achievement across the four stages before and after the intervention. The largest gains were observed in devising a plan and carrying out the plan, whereas understanding the problem showed the smallest increase. Looking back also improved but remained considerably lower than the other stages. This pattern indicates that students showed greater improvement in developing and implementing solution strategies than in reviewing and evaluating their solutions.

The improvement in understanding the problem, devising a plan, and carrying out the plan can be related to the learning activities characteristic of PBL. Students were engaged in identifying relevant information, discussing possible approaches, formulating solution strategies, and implementing those strategies through collaborative inquiry. These activities are conceptually aligned with Polya's first three stages (Polya, 1945). Classroom discussions also provided opportunities for students to exchange ideas, compare approaches, and justify their reasoning. Such experiences may have supported the development of students' strategic and procedural aspects of problem solving, particularly when working with contextual statistical problems. This interpretation is consistent with previous findings that PBL can support mathematical problem-solving strategies through active engagement in authentic learning situations (Sari et al., 2022).

The particularly large increases in devising a plan and carrying out the plan indicate that these aspects showed substantial development following PBL implementation. Before the intervention, achievement in these stages was relatively low, at 41.94% and 22.58%, respectively. After the intervention, the corresponding percentages increased to 87.10% and 70.97%. This pattern suggests that the PBL activities provided opportunities for students to move from identifying possible approaches to implementing mathematical procedures. However, because the study used a one-group pretest–posttest design, these changes should be interpreted as improvements observed following PBL implementation rather than as evidence that PBL alone caused the changes.

In contrast, looking back remained the least developed stage despite increasing from 3.23% to 38.71%. This finding indicates that students showed comparatively less achievement in reviewing and evaluating their solutions than in the other stages. Susanti and Arifin (2022) similarly reported difficulties related to reflective and metacognitive aspects of mathematical problem solving among junior secondary students. Reviewing a solution requires students to monitor their reasoning, identify possible errors, assess the validity of their results, and consider whether the solution is reasonable. These activities may require more explicit attention during instruction than activities focused on obtaining and implementing a solution.

The relatively low achievement in looking back suggests that PBL implementation may benefit from more explicit opportunities for reflection and evaluation. Teachers can incorporate prompts that ask students to justify the reasonableness of their answers, identify possible errors, or compare alternative solution methods. Such activities can be embedded in worksheets and classroom discussions to provide structured opportunities for students to review their problem-solving processes. These instructional implications are consistent with the finding that improvement in the looking-back stage was smaller in absolute achievement than in the planning and implementation stages.

An important contribution of this study is its stage-specific examination of mathematical problem-solving performance within PBL-based Statistics learning. Whereas previous studies have often emphasized overall achievement, the present findings show that improvement was not uniform across Polya's four stages. The largest gains were observed in carrying out the plan and devising a plan, while looking back remained the least developed stage after the intervention. This stage-specific pattern provides more detailed information about students' problem-solving development than an overall score alone and indicates an area that may require additional instructional support.

Overall, students' mathematical problem-solving performance improved following the implementation of PBL, as indicated by the increase in mean scores, the moderate N-Gain, the increase in classical mastery, and the statistically significant pretest–posttest difference. The stage-specific analysis further shows that improvement occurred across all four Polya stages, with the greatest gains in carrying out the plan and devising a plan, while looking back remained the most challenging stage. These findings support the use of PBL as an instructional approach for engaging students in mathematical problem solving in Statistics, while also highlighting the need for explicit reflective activities to strengthen the evaluation stage of the problem-solving process.

Conclusion and Suggestion

This study found that students' mathematical problem-solving performance in Statistics improved following the implementation of Problem-Based Learning (PBL). The improvement was observed not only in overall performance but also across all four stages of Polya's problem-solving framework. The greatest gains occurred in devising a plan and carrying out the plan, indicating substantial development in students' ability to formulate and implement solution strategies. These findings support the potential of PBL as a student-centered approach for engaging students in systematic mathematical problem solving through contextual and collaborative learning activities.

However, looking back remained the least developed stage after the intervention, despite showing improvement from the pretest to the posttest. This finding indicates that students may require additional support in reviewing, justifying, and evaluating their solutions. Therefore, teachers are encouraged to incorporate explicit reflection prompts and metacognitive scaffolding into PBL activities, such as asking students to examine the reasonableness of their answers, identify possible errors, and evaluate their solution strategies. Future research may investigate instructional strategies specifically designed to strengthen reflective and evaluative aspects of mathematical problem solving within PBL-based mathematics learning.

References

Apryanti, H., Ismail, F., & Fitrianti, Y. (2017). Penerapan teknik pemecahan masalah model Polya terhadap kemampuan menyelesaikan soal cerita matematika pada peserta didik kelas VIII SMP Negeri 46 Palembang. Jurnal Pendidikan Matematika RAFA, 1(2), 224–243. https://jurnal.radenfatah.ac.id/index.php/jpmrafa/article/view/1232

Barrows, H. S. (1996). Problem-based learning in medicine and beyond: A brief overview. New Directions for Teaching and Learning, 1996(68), 3–12. https://doi.org/10.1002/tl.37219966804

Dochy, F., Segers, M. S. R., van den Bossche, P. G., & Gijbels, D. (2003). Effects of problem-based learning: A meta-analysis. *Learning and Instruction, 13*(5), 533–568. https://doi.org/10.1016/S0959-4752(02)00025-7

Faoziyah, N. (2022). Kemampuan pemecahan masalah matematis siswa melalui pembelajaran berbasis PBL. *JUPE: Jurnal Pendidikan Mandala, 7*(2). https://doi.org/10.58258/jupe.v7i2.3555

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2019). How to design and evaluate research in education (10th ed.). McGraw-Hill Education.

George, D., & Mallery, P. (2003). SPSS for Windows step by step: A simple guide and reference (4th ed.). Allyn & Bacon.

Gijbels, D., Dochy, F., van den Bossche, P., & Segers, M. (2005). Effects of problem-based learning: A meta-analysis from the angle of assessment. *Review of Educational Research, 75*(1), 27–61. https://doi.org/10.3102/00346543075001027

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. American Journal of Physics, 66(1), 64–74. https://doi.org/10.1119/1.18809

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

Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia. (2022). Peraturan Menteri Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia Nomor 16 Tahun 2022 tentang standar proses pada pendidikan anak usia dini, jenjang pendidikan dasar, dan jenjang pendidikan menengah. JDIH Kemdikbudristek.

National Council of Teachers of Mathematics. (2020). Catalyzing change in early childhood and elementary mathematics: Initiating critical conversations. National Council of Teachers of Mathematics.

Organisation for Economic Co-operation and Development. (2018). The future of education and skills: Education 2030. OECD Publishing.

Organisation for Economic Co-operation and Development. (2019). PISA 2018 assessment and analytical framework. OECD Publishing.

OECD. (2023). PISA 2022 Assessment and Analytical Framework. OECD Publishing

Pólya, G. (1945). How to solve it: A new aspect of mathematical method. Princeton University Press.

Sari, I. W., Kesumawati, N., & Sari, E. F. P. (2022). Pengaruh model Problem Based Learning terhadap kemampuan berpikir kreatif matematis berdasarkan self-esteem peserta didik. Jurnal Pendidikan Matematika RAFA, 8(2), 168–178. https://doi.org/10.19109/jpmrafa.v8i2.13405

Soliha, I., & Amidi. (2025). Implementasi model PBL dengan pendekatan berdiferensiasi berbantuan GeoGebra terhadap kemampuan pemecahan masalah matematis. Jurnal Pendidikan dan Teknologi Indonesia, 5(9), 2672–2683. https://doi.org/10.52436/1.jpti.1068

Susanti, E., & Arifin, S. (2022). Kebiasaan berpikir matematis peserta didik SMP dalam menyelesaikan masalah statistika. Jurnal Pendidikan Matematika RAFA, 8(2), 179–192. https://doi.org/10.19109/jpmrafa.v8i2.14670

Walker, A., & Leary, H. (2009). A problem based learning meta analysis: Differences across problem types, implementation types, disciplines, and assessment levels. *Interdisciplinary Journal of Problem-Based Learning, 3*(1), 6–28. https://doi.org/10.7771/1541-5015.1061