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THE EFFECT OF PROBLEM-BASED LEARNING IMPLEMENTATION ON STUDENTS' PROBLEM-SOLVING ABILITY IN PROBABILITY TOPICS

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ABSTRACT
This study aims to determine the effect of implementing the Problem-Based Learning (PBL) model on students' problem-solving skills in probability. This study uses a quantitative approach with an experimental method. The study population consists of students at STIE Jambatan Bulan who are enrolled in the Statistics course. The sample comprises 32 students divided into two groups: 16 students in the experimental group, who received instruction using the Problem-Based Learning model, and 16 students in the control group, who received conventional instruction. The research instrument consists of a problem-solving ability test on probability material. Data analysis was conducted through normality tests, homogeneity tests, and hypothesis testing using the t-test at a 5% significance level. The results showed that the average problem-solving ability of students in the experimental class was 83.187, while the average problem-solving ability of students in the control class was 73.125. The results of the hypothesis testing showed that the calculated t-value (t-hitung) of 4.312 was greater than the critical t-value (t-table) of 1.697; therefore, H0 was rejected and H1 was accepted. Thus, the implementation of the Problem-Based Learning model has a positive effect on students' problem-solving skills in probability. The Problem-Based Learning model has proven to be more effective than conventional teaching methods in improving students' ability to understand, analyze, and solve problems related to probability concepts in statistics courses.

INTRODUCTION

Mathematics is a discipline that plays a crucial role in developing logical, analytical, critical, and systematic thinking skills. These competencies are essential across various fields, including economics, business, and statistics. According to Bangki et al. (2024), mathematics functions not only as a tool for solving numerical problems but also as a means of cultivating rational and structured ways of thinking. Therefore, mathematics instruction at the tertiary level should be designed to foster students' higher-order thinking skills.

Higher education institutions are responsible for producing graduates who are capable of addressing challenges in both professional and everyday contexts. One essential competency that must be developed is problem-solving ability. This ability enables students to identify problems, analyze available information, select appropriate strategies, and formulate effective solutions. In the context of statistics education, problem-solving skills are particularly important because students are required to apply statistical concepts in a variety of real-world situations.

Statistics is a course that encompasses numerous mathematical concepts, including probability. Probability serves as a fundamental basis for understanding inferential statistics and data-driven decision-making. However, many students still encounter difficulties in

understanding probability concepts because the topic requires not only computational skills but also the ability to analyze and interpret situations involving uncertainty. Consequently, students' problem-solving skills in probability remain suboptimal.

Based on observations conducted during Statistics classes at STIE Jambatan Bulan, many students tended to memorize formulas without fully understanding the underlying concepts. As a result, when confronted with problems that differed from the examples provided by the lecturer, they experienced difficulties in determining appropriate solution strategies. This condition suggests that the learning process must be improved to better develop students' critical thinking and problem-solving abilities.

One factor influencing students' problem-solving skills is the instructional model employed. Firdaus, A. M., & Herwandi, H. (2023) Lecturer-centered learning often results in passive students who merely receive information without actively engaging in the learning process. According to Marpaung (2021), the use of less engaging instructional models can reduce students' learning motivation, which subsequently affects learning outcomes and critical thinking skills. Therefore, instructional models that encourage active student participation in constructing their own knowledge are required.

One instructional model that can address these issues is Problem-Based Learning (PBL). Sape, H., & Masril Aguswandi Tudjuka. (2025) PBL is a student-centered learning model that positions problems as the starting point of the learning process. Isnani (2023) and Yang (2025) explained that PBL provides learners with opportunities to actively engage in inquiry and problem-solving processes, thereby enhancing conceptual understanding and higher-order thinking skills.

Numerous studies have reported positive outcomes from implementing PBL in mathematics education. Bangki et al. (2024) found that PBL improved students' learning outcomes compared with direct instruction. Furthermore, Kembau et al. (2025) reported that PBL positively affects mathematics achievement because students are actively involved in learning through discussions, investigations, and presentations of problem-solving results.

Another advantage of PBL is its capacity to enhance critical thinking and independent learning. According to Supit et al. (2023), PBL enables students to construct knowledge independently through meaningful learning experiences. Rahmawati and Susilo (2025) further argued that problem-based learning improves critical thinking skills because students become accustomed to confronting and solving problems related to real-life contexts.

In learning probability, the application of PBL is expected to help students develop a deeper understanding of concepts. Through contextual problems related to probability, students not only learn concepts theoretically but also develop the ability to analyze information, formulate solution strategies, and evaluate outcomes. Consequently, learning becomes more meaningful and relevant to students' needs.

Based on the foregoing discussion, it is necessary to investigate the effect of implementing the PBL model on students' problem-solving skills in probability. This study was conducted among students of STIE Jambatan Bulan enrolled in the Statistics course. The findings are expected to contribute to the development of more effective instructional strategies for improving students' problem-solving skills, particularly in probability.

METHODS

This study employed an experimental method with a quantitative approach. The objective was to determine the effect of implementing the Problem-Based Learning (PBL) model on students' problem-solving skills in probability. The research design used was a Posttest-Only Control Group Design, involving an experimental group and a control group that received different treatments and were subsequently assessed through a posttest.

The study was conducted at STIE Jambatan Bulan during the second semester of the 2025/2026 academic year. The population consisted of all students enrolled in the Statistics course. The sample was selected using purposive sampling based on similarities in students' academic characteristics. The sample comprised two groups, each consisting of 16 students.

The experimental group received instruction using the PBL model, whereas the control group received conventional instruction.

The independent variable was the PBL instructional model, while the dependent variable was students' problem-solving skills in probability. Problem-solving skills included the ability to understand problems, formulate solution strategies, implement solutions, and evaluate obtained results.

The research instrument was an essay-based problem-solving test consisting of five questions on probability. Prior to its implementation, the instrument underwent content validity assessment through expert judgment involving Statistics lecturers and mathematics education experts. Reliability testing was also conducted to ensure measurement consistency.

The research procedure began with the implementation of PBL in the experimental group. Students were presented with contextual problems related to probability and were required to analyze and solve them through discussion, investigation, and presentation activities. Meanwhile, the control group received conventional instruction centered on lecturer explanations and practice exercises.

After all probability topics had been taught, both groups completed the same posttest to assess their problem-solving skills. The test results were then collected and analyzed to determine differences between the experimental and control groups.

Data analysis was conducted in two stages: descriptive and inferential analyses. Descriptive statistics were used to describe the mean, maximum score, minimum score, standard deviation, and variance of students' problem-solving skills. Inferential statistics were subsequently employed to test the research hypothesis.

Prior to hypothesis testing, prerequisite tests including normality and homogeneity tests were conducted. Normality was examined using the Kolmogorov–Smirnov test, while homogeneity was assessed using Levene's test. Hypothesis testing was performed using an Independent-Samples t-Test at a 5% significance level with the assistance of SPSS for Windows.

RESULTS AND DISCUSSION

Research Findings

This study was conducted among students of STIE Jambatan Bulan who had enrolled in the Statistics course. The research sample consisted of two groups: (1) an experimental group comprising 16 students who received instruction using the Problem-Based Learning (PBL) model, and (2) a control group comprising 16 students who received instruction through a conventional learning model.

The variable measured in this study was students' problem-solving ability in probability topics. The measurement was carried out using a problem-solving ability test administered after the completion of the instructional process (posttest).

The results of the posttest data analysis on students' problem-solving ability in both the experimental and control groups are presented in Table 1.

Table 1. Descriptive Statistics of Students' Problem-Solving Ability

Statistic	Experimental Group	Control Group
Minimum Score	54	50
Maximum Score	97	95
Total Score	1.331	1.170
Mean	83,187	73,125
Standard Deviation	12,297	12,093
Variance	151,229	146,249

Based on Table 1, it can be observed that the mean score of students' problem-solving ability in the experimental group was 83.187, whereas the mean score in the control group was 73.125. This difference in mean scores indicates that students who received instruction

through the Problem-Based Learning (PBL) model demonstrated higher problem-solving ability than those who received conventional instruction.

A normality test was conducted using SPSS for Windows to determine whether the data on students' problem-solving ability were normally distributed. The test was performed using the Kolmogorov–Smirnov test.The results of the normality test are presented in Table 2.

Table 2. Results of the Normality Test

Group	Kolmogorov–Smirnov Statistic	N	Sig.
Experimental (PBL)	0,193	16	0,057
Control	0,132	16	0,200

The significance value for the experimental group was 0.057, while that for the control group was 0.200. Both values were greater than 0.05, indicating that the data on students' problem-solving ability in both groups were normally distributed.

A homogeneity test was subsequently conducted to determine the equality of variances between the two sample groups. The test was performed using Levene's Test with the assistance of SPSS for Windows. The results of the homogeneity test are presented in Table 3.

Table 3. Results of the Homogeneity Test

Levene Statistic	df1	df2	Sig.
0,030	1	30	0,864

The results of the homogeneity test revealed a significance value of 0.864. Since this value exceeded 0.05, it indicates that the variances of the two groups were homogeneous, thereby satisfying the assumption required for subsequent hypothesis testing.

Hypothesis testing was conducted using an Independent Samples t-test with the assistance of SPSS for Windows. The results showed a t-value of 4.312, with the mean problem-solving ability score of students in the experimental group being 83.187, compared to 73.125 in the control group. These findings indicate a difference in problem-solving ability between students who learned through the Problem-Based Learning (PBL) model and those who learned through the conventional learning model. Therefore, the PBL model had a positive effect on students' problem-solving ability in probability topics.

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Discussion

The findings of this study indicate that the implementation of the Problem-Based Learning (PBL) model had a positive effect on students' problem-solving ability in probability topics. This finding is reflected in the higher mean score of problem-solving ability achieved by students in the experimental group compared to those in the control group. The difference suggests that the PBL model is capable of creating a more effective learning process in developing students' ability to understand and solve problems related to probability concepts.

One of the main strengths of the PBL model lies in its student-centered learning approach. In this model, students are confronted with contextual problems that require them to identify problems, gather information, formulate solution strategies, and evaluate the outcomes obtained. Such conditions encourage students to actively engage in the learning process, leading to a deeper conceptual understanding. This finding is consistent with the views of Padang et al. (2025) and Sakir and Kim (2020), who argued that PBL enhances the quality of learning through students' active involvement in solving authentic problems.

The mean difference of 10.062 points in problem-solving ability between the experimental and control groups indicates that problem-based learning makes a significant contribution to students' mastery of probability concepts. Students not only learn how to apply probability formulas but also develop an understanding of how these concepts can be applied in various real-world situations. This result supports the findings of Chiu and Ho (2024), who stated that problem-based learning enables learners to construct knowledge independently through investigation and problem-solving processes.

The findings are also consistent with the study conducted by Alfita et al. (2025), which reported that PBL promotes students' active engagement through collaborative activities and problem-solving tasks related to real-life situations. Through this process, students' critical thinking skills and conceptual understanding can develop more effectively. Furthermore, PBL prepares students to face various real-world challenges by fostering adaptability, resilience, and decision-making skills in problem-solving situations, although its successful implementation requires careful planning and effective instructional management.

During the learning process, students in the experimental group demonstrated more active participation in group discussions, expressed their opinions more frequently, and engaged more actively in solving the problems provided. These activities offered opportunities for students to develop critical thinking skills, mathematical communication skills, and collaborative abilities. This finding is supported by previous studies indicating that PBL enhances conceptual understanding and critical thinking skills through students' engagement in authentic problem-solving experiences (Sinaga & Prayitno, 2023). This model emphasizes the importance of communication, collaboration, and the utilization of various learning resources during the problem-solving process. Through these collaborative activities, students are able to interpret information, evaluate alternative solutions, and develop deeper reasoning skills when confronted with realistic problems.

These findings are also in line with the argument proposed by Marpaung (2021), who explained that the PBL model can enhance learning motivation and student engagement because instruction is oriented toward solving problems that are relevant to real-life situations. The findings are further reinforced by previous studies demonstrating that PBL significantly improves students' critical thinking and problem-solving abilities while simultaneously enhancing motivation, active participation, and self-confidence throughout the learning process (Khoso & Sahito, 2025).

Moreover, the successful implementation of PBL is influenced by the role of the lecturer as a learning facilitator. The lecturer is not merely responsible for delivering instructional content but also guides students in identifying problems, seeking relevant information, and evaluating alternative solutions. This approach provides students with opportunities to develop independent learning skills and higher-order thinking abilities. These findings support the results of Rahmawati and Susilo (2025), who reported that PBL enhances students' critical thinking skills in mathematics learning. Furthermore, the findings of this study are supported by other research indicating that learning approaches oriented toward the development of higher-order thinking skills can improve critical thinking, conceptual understanding, and active engagement in mathematics learning (Nirfayanti et al., 2025). These improvements occur because students are given opportunities to explore concepts, analyze information, and connect their prior knowledge with the problems they encounter. These characteristics are consistent with the principles of PBL, which position students as active problem solvers and thereby strengthen their ability to solve various problems related to probability topics.

Overall, the findings of this study provide empirical evidence that PBL is an effective instructional model for improving students' problem-solving ability in probability topics. Therefore, the implementation of the PBL model can be considered an alternative instructional approach in Statistics courses to help students develop a deeper understanding of probability concepts while simultaneously enhancing the critical thinking and problem-solving skills required in both academic and professional contexts.

CONCLUSION

Based on the findings and discussion, it can be concluded that the implementation of the Problem-Based Learning (PBL) model had a positive effect on students' problem-solving ability in probability topics. This is evidenced by the mean problem-solving ability score of students in the experimental group, who received instruction through the Problem-Based Learning model, which was 83.187, compared to 73.125 in the control group, who received conventional instruction.

The results of the data analysis indicate that students who learned through the PBL model demonstrated better abilities in understanding problems, planning solution strategies, implementing solutions, and evaluating the outcomes obtained in probability topics. Through a problem-centered learning approach, students became more actively engaged in the learning process, developed stronger critical thinking skills, and demonstrated greater proficiency in applying probability concepts to various relevant situations.

Therefore, the PBL model can be considered an effective alternative instructional approach for Statistics courses, particularly in probability topics, to improve students' problem-solving ability at STIE Jambatan Bulan.

REFERENCES

Alfita, N. A., Harianto, D., Alfita, N. A., Ramadhani, N., Wahid, Abd., Sukri, M. A., & Fahlan, Muh. F. (2025). Efektivitas Strategi Pembelajaran Berbasis Masalah Dalam Meningkatkan Kemampuan Berfikir Siswa. *Contemporary Education Review*, *1*(1), 10–19. https://doi.org/10.69875/cer.v1i1.297

Bangki, N. T., Mangobi, J. U. L., & Kaunang, D. F. (2024). Studi Komparasi Hasil Belajar Teorema Pythagoras Siswa yang Diajarkan Menggunakan Model Problem-Based Learning dengan Direct Instruction. *Jurnal Riset Dan Inovasi Pembelajaran*, *4*(2), 1159–1170. https://doi.org/10.51574/jrip.v4i2.1609

Chiu, Y.-L., & Ho, C.-H. (2024). Using an Online Knowledge-Construction Platform to Explore Collaborative Inquiry Activities of Problem-Based Learning. *2024 16th IIAI International Congress on Advanced Applied Informatics (IIAI-AAI)*, 687–688. https://doi.org/10.1109/IIAI-AAI63651.2024.00138

Firdaus, A. M., & Herwandi, H. (2023). Students' Mathematics Problem-Solving Ability With Kinesthetic Learning Style At Vocational School. *Lentera Pendidikan: Jurnal Ilmu Tarbiyah Dan Keguruan*, *26*(1), 153–170. https://doi.org/10.24252/lp.2023v26n1i11

Isnani, T. (2023). Implementation of Project-Based Learning Approach in Improving Critical Thinking Skills of Elementary School Students. *Jurnal Ar Ro'is Mandalika (Armada)*, *3*(1), 47–55. https://doi.org/10.59613/armada.v3i1.2844

Kembau, E. K., Wenas, J. R., & Regar, V. E. (2025). Pengaruh Penerapan Model Pembelajaran Problem Based Learning Dalam Meningkatkan Hasil Belajar Siswa Pada Materi Segi Tiga Kelas VII SMP Negeri 1 Tumpaan. *De Fermat : Jurnal Pendidikan Matematika*, *8*(1), 326–333. https://doi.org/10.36277/defermat.v8i1.2294

Khoso, F. J., & Sahito, Z. H. (2025). Examining the Impact of Project-Based Learning Approaches on High School Students' Critical Thinking and Problem-Solving Skills in STEM Education. *Qlantic Journal of Social Sciences and Humanities*, *6*(4), 191–207. https://doi.org/10.55737/qjssh.vi-iv.25440

Marpaung, R. (2021). Penerapan Model Pembelajaran Problem Based Learning untuk Meningkatkan Hasil Belajar dan Keaktifan Siswa. *Jurnal Informatika Dan Teknologi Pendidikan*, *1*(1), 16–22. https://doi.org/10.25008/jitp.v1i1.6

Nirfayanti, Setyawan, D., & Djafar, S. (2025). Development of AR-integrated inductive thinking-based teaching modules to improve critical thinking and mathematical generalisation skills. *Multidisciplinary Science Journal*, *8*(6), 2026405. https://doi.org/10.31893/multiscience.2026405

Padang, N. S., Nirfayanti, & Narew, I. (2025). Efektivitas Modul Ajar Berbasis Problem Based Learning Terintegrasi Geogebra untuk Meningkatkan Kemampuan Berpikir Kritis Mahasiswa. *EQUALS: Jurnal Ilmiah Pendidikan Matematika*, *8*(2), 191–199. https://doi.org/10.46918/equals.v8i2.2930

Rahmawati, N. D., & Susilo, G. (2025). Kemampuan Berpikir Kritis Mahasiswa Pada Pembelajaran Problem Based Learning Bernuansa Etnomatematika. *De Fermat : Jurnal Pendidikan Matematika*, *8*(1), 397–404. https://doi.org/10.36277/defermat.v8i1.2311

Sakir, N. A. I., & Kim, J. G. (2020). Enhancing Students' Learning Activity and Outcomes via Implementation of Problem-based Learning. *Eurasia Journal of Mathematics, Science and Technology Education*, *16*(12), em1925. https://doi.org/10.29333/ejmste/9344

Sinaga, R. M., & Prayitno, A. J. (2023). Meningkatkan Kemampuan Berpikir Kritis Pak Dan Bp Dengan Metode PBL Pada Kelas VII SMP Negeri 3 Tebing Tinggi. *Prosiding Seminar Nasional Pendidikan dan Agama*, *4*(2), 1227–1242. https://doi.org/10.55606/semnaspa.v4i2.1362

Sape, H., & Masril Aguswandi Tudjuka. (2025). Pengaruh PBL Terhadap Kemampuan Pemecahan Masalah Matematis Siswa Di Era Kurikulum Merdeka. *Jurnal Penalaran dan Riset Matematika*, *4*(1), 54–63. https://doi.org/10.62388/prisma.v4i1.545

Supit, C. M., Sulistyaningsih, M., & Kaunang, D. F. (2023). Penerapan Model Problem Based Learning dengan Pendekatan Pendidikan Matematika Realistik dalam Pembelajaran Matematika Materi Sistem Persamaan Linear Dua Variabel. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *7*(3), 2932–2940. https://doi.org/10.31004/cendekia.v7i3.2583

Yang, H. (2025). Problem-Based Learning: An Effective Path to Promote Students' Critical Thinking in High School English Reading Teaching. *Region - Educational Research and Reviews*, *7*(4), 169–173. https://doi.org/10.32629/rerr.v7i4.3877