Indonesian Journal of Educational Science
ISSN 2662-6197 (online)
Volume 7 No 2, March 2025
ISSN 2655-4402 (print)

Analysis of Teacher Perceptions on Problem-Based Learning to Improve the Mathematical Abilities of Vocational High School Students

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(Received:19 December 2024; Accepted: 12 March 2025)

Abstract

This research aims to analyze the perceptions of vocational high school mathematics teachers towards Problem-Based Learning and evaluate the effectiveness of this method in improving students' mathematical problem-solving abilities. This research is important because mathematical problem-solving skills are essential competencies that support students' critical and creative thinking skills, yet they remain low in many schools. This research uses a mixed-method approach with a quantitative questionnaire to measure teachers' perceptions of problem-based learning and qualitative interviews to explore more in-depth information. The participants were 45 vocational high school mathematics teachers in Kendal Regency who were selected using purposive sampling. Data were analyzed descriptively to identify patterns in teachers' perceptions and to analyze interviews to understand the challenges of implementing the method. The results show that most teachers positively perceive problem-based learning, with 80% agreeing that this skill is essential. However, the main obstacles are the lack of teacher competence in innovative learning strategies and limited facilities. This research recommends continuous training for teachers and the development of problem-based modules to support the successful implementation of problem-based learning.
Keywords: *problem-based learning, mathematical problem-solving skills, teacher perception*

Abstrak

Penelitian ini bertujuan untuk menganalisis persepsi guru matematika SMK terhadap pembelajaran berbasis pemecahan masalah (Problem-Based Learning) dan mengevaluasi efektivitas penerapan metode ini dalam meningkatkan kemampuan pemecahan masalah matematis siswa. Penelitian ini penting dilakukan karena kemampuan pemecahan masalah matematis merupakan kompetensi esensial yang mendukung keterampilan berpikir kritis dan kreatif siswa, namun masih rendah di banyak sekolah. Penelitian ini menggunakan metode campuran dengan kuesioner kuantitatif untuk mengukur persepsi guru terhadap pembelajaran berbasis masalah dan wawancara kualitatif untuk menggali informasi lebih mendalam. Partisipan adalah 45 guru matematika SMK di Kabupaten Kendal yang dipilih menggunakan teknik *purposive sampling*. Data dianalisis secara deskriptif untuk mengidentifikasi pola persepsi guru, serta menganalisis wawancara untuk memahami tantangan implementasi metode tersebut. Hasil menunjukkan bahwa mayoritas guru memiliki persepsi positif terhadap pembelajaran berbasis pemecahan masalah, dengan 80% menyatakan setuju bahwa kemampuan ini sangat penting. Namun, kurangnya kompetensi guru dalam strategi pembelajaran inovatif dan keterbatasan fasilitas menjadi kendala utama. Penelitian ini merekomendasikan pelatihan berkelanjutan bagi guru dan pengembangan modul berbasis masalah untuk mendukung keberhasilan implementasi pembelajaran berbasis pemecahan masalah.
Kata kunci: *pembelajaran berbasis masalah, kemampuan pemecahan masalah matematis, persepsi guru*

INTRODUCTION

Problem-solving skills in mathematics education are not just essential; they are crucial. They are the key to solving mathematical problems and developing analytical, critical, and systematic thinking skills necessary for real-life challenges (Lestari, 2020). Problem-based learning (PBL) has been proven to be an effective tool in enhancing these skills. It encourages students to actively participate and apply problem-solving strategies based on real-world contexts, strengthening their conceptual understanding and logical thinking skills (Kabael & Baran, 2023). Despite its effectiveness, many students still face difficulties, indicating the need

for more creative teaching approaches and support for metacognitive development to create a conducive learning environment (Kalamu & Talib, 2020). Therefore, focusing on strengthening mathematical problem-solving skills through PBL becomes an essential investment in preparing students to face future challenges in both educational and professional fields (Davita & Pujiastuti, 2020).

Mathematical problem-solving ability is one of the core competencies in the mathematics education curriculum, as it supports students' academic achievements and equips them with essential critical and creative thinking skills for everyday life (Astuty and Winarso,2021). However, various studies indicate that this ability remains low among vocational high school students, primarily due to the limited application of innovative learning methods such as Problem-Based Learning (PBL) (Asdamayanti et al., 2023). Therefore, it is essential to analyze teachers' perceptions of PBL as a determining factor for successfully implementing this method.

Mathematics plays a fundamental role in the development of students' thinking skills, particularly in the context of critical and creative thinking. Critical thinking skills in mathematics help students solve mathematical problems and make better decisions in everyday life (Yanuari, 2023). These skills include analysis, evaluation, and concluding the information obtained, which are integral to mathematics learning (Ariawan et al., 2022). In addition, creative thinking skills enable students to find various solutions to their problems (Yuliyanto et al., 2021). Learning in the Merdeka Curriculum emphasizes the importance of students' reasoning, problem-solving, and communicating mathematical ideas, so teachers need to design effective learning to support the development of these skills (Anggreini & Priyojadmiko, 2022).

The role of the teacher in problem-based mathematics learning is crucial in enhancing students' skills in facing mathematical challenges. Teachers are material conveyors and facilitators who create a learning environment that supports exploration and collaboration (Mosimege, 2021). Teachers need to understand effective instructional strategies, such as using the Problem-Based Learning (PBL) model, which has been proven to improve student learning outcomes (Jatmiko, 2018; Ramadhani, 2023). Additionally, the problem-solving approach helps students develop critical and creative thinking skills, which are essential in mathematics learning (Rostika & Junita, 2017; Smith & Mancy, 2018). The ability of teachers to design problem-based learning, identify student difficulties, and overcome obstacles such as lack of motivation and mathematical literacy becomes a determinant of learning success (Hendri & Kenedi, 2018; Nugraha, 2023). Group discussions and cooperative learning encourage students to engage actively, optimizing their logical thinking and problem-solving abilities (Islahiyah et al., 2021; Nugroho & Dwijayanti, 2019).

Students' problem-solving abilities in mathematics learning remain a significant challenge, where many students struggle to solve non-routine problems due to a low understanding of mathematical concepts (Asdamayanti et al., 2023; Ridwan, 2021). These challenges include [specific challenges]. Moreover, math anxiety also affects students' critical and creative thinking abilities, hindering their efforts to solve problems analytically (Adhimah & Ekawati, 2020). The conventional approach, which lacks active student involvement, exacerbates this problem, as students rarely practice problem-solving (Kalamu & Talib, 2020; Purnama et al.., 2021; Sriwahyuni & Maryati, 2022). The lack of problem-based learning models causes students to give up and lose motivation when facing complex problems (Rigusti & Pujiastuti, 2020). To address this issue, recent research emphasizes the importance of developing problem-based learning modules, which are expected to enhance students' problem-solving skills and overall academic achievement (Nurmeidina et al., 2021; Yusup, 2022).

Referring to the existing challenges, it is essential to identify teachers' perceptions of problem-based learning (PBL) and their commitment to developing students' mathematical

skills. The understanding and skills of teachers in designing problem-based learning significantly influence the effectiveness of teaching and the development of students' abilities (Febriani et al., 2021). The teacher's ability to analyze student characteristics is also key in designing learning that can accommodate individual differences among students. Teachers with a deep understanding of PBL tend to be more positive in its application, which improves students' problem-solving abilities (Asta, 2023). Based on this consideration, this study aims to analyze mathematics teachers' knowledge of problem-solving learning and evaluate the extent of their commitment to implementing effective learning to improve students' mathematical problem-solving abilities. This research is expected to provide insights into more innovative teaching strategies and support the development of problem-based learning modules. In addition, the results of this research can serve as a basis for continuous training for teachers to enhance their competence in implementing learning models that support students' problem-solving abilities. Thus, this research significantly improves the quality of mathematics education in vocational schools.

METHOD

This research uses a mixed-method approach that combines quantitative and qualitative data to provide a more comprehensive picture of teachers' perceptions of problem-based learning in vocational high schools. This approach was chosen because it allows researchers to not only measure the level of perception numerically but also delve into teachers' views through in-depth interviews. The design of this research includes three main stages: quantitative data collection through questionnaires, qualitative data collection through interviews, and combined analysis to produce holistic conclusions. This research refers to the theoretical framework developed by Sakshaug & Wohlhuter (2010) on the decomposition of mathematical problems, as well as the Problem-Based Learning (PBL) model, which includes problem identification, solution planning, implementation, and reflection (Hodiyanto, 2017; Sumartini, 2018). With this approach, this research aims to answer the research questions systematically and in-depth. The use of mixed methods also allows researchers to address the limitations of each technique, such as the lack of depth in quantitative data or limited generalizability in qualitative data (Creswell & Creswell, 2018). Additionally, the design of this research aligns with the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), which emphasizes a thorough analysis of the key components in learning (Anggreini & Priyojadmiko, 2022).

The participants in this study are 45 mathematics teachers from four vocational high schools in Kendal Regency, selected using a purposive sampling technique. This technique was chosen to ensure that the participants have more than two years of teaching experience, so they have a sufficient understanding of the implementation of problem-based learning. These teachers are considered relevant informants because they are directly involved in designing and implementing mathematics instruction in the classroom. In addition, the characteristics of the participants include various educational backgrounds and teaching experiences to ensure broad representation. This study also considers gender, age, and school location as demographic variables that may influence teachers' perceptions of problem-based learning (Amam, 2017; Asdamayanti et al., 2023). Participants must provide deep insights into the challenges and opportunities in implementing problem-based learning. The selection of research subjects is based on the principle that teachers are the key to successfully implementing the curriculum and teaching strategies (Mosca & Curtis, 2019). Therefore, involving teachers as research subjects will provide relevant and meaningful data to answer the research questions.

The research instrument consists of two main parts: a quantitative questionnaire and a qualitative interview guide. The questionnaire measures teachers' perceptions of problem-based

learning with six leading indicators: the importance of problem-solving skills, student skill development, lesson planning, teaching methods, learning evaluation, and confidence in improving student abilities. This questionnaire was validated by two experts to ensure the reliability and validity of the instrument before being used in the research (Akbar et al., 2017; Fitriani, 2020). The interview guidelines are designed to delve deeper into the challenges of implementing problem-based learning, curriculum support, and evaluation methods used by teachers. This instrument also includes open-ended questions to give respondents the freedom to express their views (Haji et al., 2017; Kabael & Baran, 2023). Using validated and reliable instruments is crucial to ensure that the data collected is accurate and can be used to draw valid conclusions (Siswono et al., 2022).

Data collection was conducted in two stages: quantitative data collection through questionnaires and qualitative data collection through interviews. The questionnaire was distributed via Google Forms to 45 vocational high school mathematics teachers in Kendal Regency. At the same time, interviews were conducted online using the Zoom platform to ensure flexibility in time and place. The data collection process was carried out over one semester to ensure that the obtained data covered various learning contexts. Before data collection, the questionnaire instrument was piloted with a small group of teachers to ensure the clarity and practicality of the questions (Ginanjar, 2019; Radiusman, 2020). Qualitative data were collected through semi-structured interviews, allowing the researcher to investigate teachers' perceptions of problem-based learning. Interviews were recorded with the participants' consent and then transcribed for further analysis (Aktan et al., 2021; Hodiyanto, 2017). This data collection process ensures that the obtained data encompasses various aspects relevant to the research objectives.

The collected data were analyzed using a descriptive approach for quantitative data and thematic analysis for qualitative data. Quantitative data were analyzed descriptively to identify patterns in teachers' perceptions of problem-based learning. In contrast, qualitative data were analyzed using thematic analysis to determine the main themes that emerged from the interviews (Braun & Clarke, 2006). Quantitative data analysis includes calculating the percentage of responses for each indicator in the questionnaire, while qualitative data analysis involves coding raw data, grouping codes into themes, and interpreting findings based on relevant literature (Hingnasari, 2023; Jana & Fahmawati, 2020).

RESULT AND DISCUSSION

Data on teachers' perceptions of problem-solving learning were obtained through questionnaires distributed via Google Forms and interviews. The participants were 45 Mathematics Teachers from vocational schools in Kendal Regency for the 2024/2025 academic year. The results of the questionnaire are presented in Table 1.

Table 1 Results of the teacher perception questionnaire

No	Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
1	Solving mathematical problems is very important for vocational high school students.	80.00%	20.00%	-	-
2	Mathematics education needs to focus on developing the mathematical problem-solving abilities of vocational high school students.	66.67%	33.33%	-	-

No	Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
3	Learning planning affects the mathematical problem-solving abilities of vocational high school students.	60.00%	40.00%	-	-
4	The applied learning method can help improve students' mathematical problem-solving skills.	73.33%	26.67%	-	-
5	The confidence of the teacher can enhance students' mathematical problem-solving skills.	26.67%	60.00%	6.67%	-
6	Solving mathematical problems is very important for vocational high school students.	80.00%	20.00%	-	-

Source: author's elaboration, 2024

The survey results reveal that teachers' perceptions of mathematical problem-solving learning are predominantly positive, with all respondents agreeing on the importance of problem-based learning for students. Specifically, 80% of teachers strongly emphasize that mathematical problem-solving skills are essential competencies that must be fostered in teaching (Adhimah & Ekawati, 2020; Asdamayanti et al., 2023). However, a notable challenge emerges despite this consensus: 6.67% of respondents express uncertainty regarding their ability to effectively enhance students' mathematical problem-solving skills, particularly in vocational high school settings. This hesitation highlights a critical gap in teachers' competencies, especially concerning innovative teaching strategies and integrating problem-based approaches into classroom practices. Furthermore, limited access to adequate facilities remains a significant barrier to implementing these strategies successfully. These findings underscore the urgent need for continuous professional development programs for teachers and the creation of tailored problem-based learning modules to address existing gaps and support the practical cultivation of students' problem-solving abilities. Such interventions could provide valuable insights and practical tools to improve teaching practices and student outcomes in mathematics education.

After distributing the questionnaire, interviews were conducted to investigate teachers' perceptions of problem-based learning. This interview yielded findings that encompass several key aspects, namely: (1) Support for the mathematics curriculum in vocational schools in fostering students' problem-solving abilities in mathematics, (2) the implementation of problem-solving integration in the learning process, (3) evaluation methods used to measure students' problem-solving abilities in mathematics, and (4) challenges faced in the application of problem-based mathematics learning. Smith & Mancy (2018) emphasize that learning analysis must encompass key aspects such as curriculum, method implementation, evaluation, and challenges.

1. Support for the mathematics curriculum in vocational schools in fostering students' abilities to solve mathematical problems

The curriculum regulates the learning process, including designing the teaching structure, selecting appropriate methods, and determining relevant learning resources (Angraini et al., 2023; Hasbi & Mahmudah, 2020). A well-designed curriculum can support educational goals, particularly in mathematics subjects, by providing a clear framework for teachers and students in teaching and learning (Ardianti & Amalia, 2022). A responsive and adaptive curriculum, such

as the Merdeka Curriculum, can enhance student engagement and encourage creativity in learning (Angga et al., 2022). The results of interviews with mathematics teachers indicate that the current Merdeka Curriculum is considered quite effective in supporting the development of mathematical problem-solving skills. Teachers feel that this curriculum provides opportunities to explore the learning process and allows them to choose models that suit students' needs, enabling a focus on developing 4C skills (critical thinking, creativity, collaboration, and Communication). The results of an interview with one of the mathematics teachers show that the current Merdeka Curriculum is considered quite effective in supporting the development of mathematical problem-solving skills. He stated:

> "T*he Merdeka Curriculum allows me to design more flexible and tailored learning to students' needs. For example, I can use a contextual approach that connects mathematical concepts with real-life situations. This helps students understand the material more easily and apply it in problem-solving."*

Mathematics learning with the Merdeka Curriculum, which is contextual, supports students' 4C skills, relates mathematical concepts to real-life situations, and enhances critical and creative thinking skills (Ardianti & Amalia, 2022). However, some teachers expressed that the facilities and infrastructure at the school are still limited, which hinders the optimal implementation of the curriculum. As revealed in an interview with one of the senior teachers:

> "*Although the Merdeka Curriculum is very supportive, its implementation is often hindered by the lack of facilities in schools." For* example*, we have difficulty implementing project-based learning because there are no computer labs or adequate internet access."*

Therefore, an effective curriculum is crucial for achieving optimal learning outcomes in mathematics education (Oktavia & Qudsiyah, 2023).

Based on the survey results, 80% of teachers strongly agree on the importance of mathematical problem-solving skills. The teachers' statements indicate that the Merdeka Curriculum supports the development of students' mathematical problem-solving skills. The support provided by this curriculum certainly makes it easier for teachers in the learning process to develop students' mathematical problem-solving skills. Therefore, the steps that need to be prepared by teachers are to design learning that not only supports but also encourages students to be active in solving mathematical problems, which is certainly in line with the principles of Independent Learning in the Independent Curriculum. Learning based on that concept is expected to create space for students to think critically and creatively when facing mathematical challenges while maximizing their potential. This emphasizes the importance of the curriculum's role in providing a framework that supports achieving more effective and meaningful mathematics learning objectives.

2. Implementation of problem-solving integration in the learning process

Integrating problem-solving in mathematics learning at vocational high schools is a strategic approach to enhancing students' ability to solve mathematical problems. Based on interviews, most teachers have implemented various strategies and methods to integrate problem-solving activities into the learning process. One of the teachers explained:

> "*I often use the Problem-Based Learning (PBL) model to make students think critically." For example, I provide a case about production cost calculations in the manufacturing industry, which is relevant to their major. Students are asked to work in groups to solve the problem."*

Additionally, the Other Teacher added:

> "*I also use the Discovery Learning method to encourage students to find solutions independently." However, the challenge is that not all students have the same motivation. Students with low math skills often give up quickly."*

These strategies and methods include providing contextual problems during apperception, group discussions to solve problems, environment-based realistic learning, and projects requiring problem-solving skills. In addition, teachers use innovative learning models such as Problem-Based Learning (PBL), Project Based Learning (PjBL), and Discovery Learning, which have proven effective in supporting mathematical problem-solving skills (Noviantii et al., 2020; Susanto et al., 2020). These learning methods encourage active student engagement, help develop critical and analytical thinking skills, and improve student learning outcomes (Imami, 2018).

In designing mathematics problem-solving learning, teachers must analyze students' characteristics, initial abilities, and the learning context. The strategies implemented include analyzing student characteristics, adjusting the weight of the material to match student abilities, formulating problems according to ability levels, and conducting initial diagnostic tests to identify students' initial skills (Rigusti & Pujiastuti, 2020). Students' responses to mathematics problem-solving instruction tend to vary, with students possessing adequate mathematical abilities giving more positive feedback than those with lesser abilities. A teacher explained:

> "*Students with a strong foundation in mathematics find it easier to adapt to problem-based learning. However, students with low abilities often find it difficult and give up quickly."*

Adjusting learning to the surrounding environment is also an important aspect to ensure the relevance of the material being taught. However, students' complaints regarding the need for prerequisite knowledge to solve mathematical problems indicate that motivation and reinforcement of basic skills are essential components in mathematics education.

3. The evaluation method measures students' ability to solve mathematical problems

Evaluating mathematics learning through modeling and contextual problem-solving is crucial for assessing students' ability to apply mathematical concepts to real-life situations (Husna et al., 2024). Mastery of mathematical ideas is the foundation for students to solve complex problems and develop higher-order thinking skills (Ginanjar, 2019). Additionally, evaluating mathematical problem-solving abilities also serves to adjust and improve the learning process to optimize students' abilities in facing various mathematical problems. Based on the interview results, although all teachers assess students' problem-solving skills, only a few conduct evaluations regularly. One of the teachers stated:

> *"I realize the importance of regular evaluations to monitor student progress." However, the administrative burden and limited time often make it challenging to carry them out consistently."*

On the contrary, Another Teacher explained that he has tried to implement routine evaluations more innovatively:

> *"I use a digital application to provide problem-solving questions periodically. This application helps me monitor students' progress in real-time and provides faster feedback."*

This is supported by survey data showing that most teachers understand the importance of regular evaluations but have not fully implemented them. The results of this evaluation serve as a basis for teachers to improve their teaching strategies and adjust learning objectives to meet students' needs better.

Evaluating mathematics learning is essential in assessing students' abilities, providing feedback, and identifying individual strengths and weaknesses (Phafiandita et al., 2022). Various evaluation methods used to measure mathematical problem-solving skills, such as Problem-Based Learning (PBL) and Contextual Teaching and Learning (CTL), have proven effective in enhancing students' critical and creative thinking skills (Tambunan, 2021). The evaluation also provides insights into the effectiveness of teaching methods and the extent to which the curriculum successfully develops relevant skills in the modern era. Thus, evaluation focuses on measuring mathematical knowledge and shaping students as skilled problem solvers, ready to face future challenges. The assessment of structured mathematical problem-solving abilities is a foundation for improving the overall quality of mathematics education.

4. The challenges faced in the implementation of problem-based mathematics learning

The implementation of problem-based learning in mathematics education faces various significant challenges. One of the main challenges is the low problem-solving abilities of students in mathematics, which is often caused by a lack of understanding of basic mathematical concepts (Utami & Wutsqa, 2017). A mathematics teacher expressed:

> *"Many students have difficulty understanding word problems because they are not used to reading carefully. In addition, they often struggle to create mathematical models from the given problems."*

In addition, external distractions such as gadget usage also pose a challenge. As per the results of the interview with another Mathematics teacher:

> *"Students are often distracted by their smartphones during lessons. This reduces their concentration and negatively impacts their learning outcomes."*

Students' dependence on technology, such as searching for answers on Google or using question-scanning apps, has also become a serious problem. A Teacher explained:

> *"Students tend to be lazy in thinking critically because they immediately look for answers online. As a result, their problem-solving skills do not develop."*

Students often struggle to understand the information in the questions and create the mathematical models needed to solve the problems (Utami & Wutsqa, 2017). In addition, conventional teaching methods, such as lectures, do not sufficiently encourage active student involvement in the learning process (Nugraha, 2023), which results in low student motivation and participation in problem-based learning (Yusup, 2022). To address this challenge, innovation in teaching methods is needed, such as implementing the Problem-Based Learning (PBL) model, which has proven effective in enhancing students' problem-solving abilities (Panggabean et al., 2022). However, the implementation of PBL also requires training for teachers to adapt this approach effectively to diverse classroom contexts (Islahiyah et al., 2021).

In addition to challenges in teaching methods, several other obstacles were found based on interviews with vocational high school mathematics teachers in Kendal Regency. First, the varying initial abilities of students become the main obstacle because concepts in mathematics are interconnected and require a solid understanding at the beginning of the learning process (Zulkarnain, 2019). A teacher, Ms. R, stated:

Students with a weak foundation in mathematics often struggle to keep up with the lessons. They tend to give up quickly when faced with more complex problems.

Second, external distractions, such as gadgets, can reduce students' concentration while studying, significantly impacting the quality of learning (Lee, 2023; Pahrudin et al., 2021). Interview results with Mr. A:

> *"Students are often distracted by their smartphones during lessons. This makes them less focused and difficult to understand the material being taught."*

Third, students' dependence on technology, such as searching for answers on Google or using question-scanning apps, causes them to think less critically, reducing their problem-solving skills (Bakri et al., 2021). Another teacher, Mrs. L, explained:

> *"Students tend to be lazy in thinking critically because they immediately look for answers online. As a result, they are not accustomed to analyzing problems in depth."*

Although various efforts have been made to improve the quality of learning, the results are still not optimal, especially regarding students' problem-solving abilities, which tend to decline. Therefore, developing and adapting more contextual learning methods that wisely incorporate technology is essential to address these challenges.

CONCLUSION

Based on the analysis results, it can be concluded that vocational school teachers in Kendal Regency favor problem-solving learning and are highly committed to developing students' mathematical problem-solving abilities. Nevertheless, students' ability to solve mathematical problems is still not optimal and tends to decline. Therefore, continuous efforts from teachers are essential to improve and refine problem-solving learning based on the evaluation results that have been conducted. Furthermore, the challenges students face, particularly those related to low initial abilities, need to be addressed with an approach that emphasizes conceptual understanding and its application in the context of problems relevant to real life.

This research has limitations: relying solely on data from questionnaires and interviews without directly observing the implementation of problem-solving learning in the classroom. Therefore, future research should include analyzing teachers' skills in applying teaching methods designed to support and optimize students' abilities, particularly in solving mathematical problems.

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