

A Literature Review of Students' Difficulties in Quadratic Equations and Problem-Solving Learning Using LKPD

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ABSTRACT

Persamaan kuadrat merupakan topik penting dalam pendidikan matematika karena berperan dalam mengembangkan kemampuan berpikir analitis dan keterampilan pemecahan masalah siswa. Namun, banyak siswa masih mengalami kesulitan ketika menyelesaikan soal-soal persamaan kuadrat. Kesulitan tersebut sering berkaitan dengan keterbatasan pemahaman konsep, kesulitan dalam menafsirkan permasalahan matematika, serta kesalahan dalam menerapkan prosedur aljabar. Penelitian ini bertujuan untuk mengidentifikasi kesulitan yang dialami siswa dalam menyelesaikan persamaan kuadrat serta mengkaji peran model pembelajaran problem solving berbantuan Lembar Kerja Peserta Didik (LKPD) dalam meningkatkan kemampuan pemecahan masalah matematis siswa. Penelitian ini menggunakan metode studi literatur dengan mengidentifikasi, menyeleksi, dan menganalisis berbagai penelitian yang relevan yang dipublikasikan dalam jurnal akademik. Hasil kajian menunjukkan bahwa siswa sering mengalami kesulitan dalam memahami konteks soal, menerjemahkan masalah ke dalam representasi matematika, serta menerapkan strategi penyelesaian secara sistematis. Selain itu, penerapan model pembelajaran problem solving yang didukung oleh LKPD dapat membantu memfasilitasi kegiatan pembelajaran yang lebih terstruktur, memperkuat pemahaman konsep, serta meningkatkan kemampuan pemecahan masalah matematis siswa.

Quadratic equations are an essential topic in mathematics education because they contribute to the development of students' analytical thinking and problem-solving abilities. However, many students still experience difficulties when solving quadratic equation problems. These difficulties are often related to limited conceptual understanding, challenges in interpreting mathematical problems, and mistakes in applying algebraic procedures. This study aims to identify the difficulties encountered by students in solving quadratic equations and to examine the role of a problem-solving learning model assisted by Student Worksheets (LKPD) in improving students' mathematical problem-solving abilities. This research employed a literature review method by systematically identifying, selecting, and analyzing relevant studies published in academic journals. The results indicate that students frequently struggle to understand problem contexts, translate problems into mathematical representations, and apply systematic solution strategies. Furthermore, the integration of a problem-solving learning model supported by LKPD can facilitate structured learning activities, strengthen conceptual understanding, and improve students' mathematical problem-solving competence.



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INTRODUCTION

The rapid development of science and technology has had a significant impact on various aspects of human life, including education. These changes require renewal and innovation in the learning process to adapt to the demands of the times. Teachers, as a crucial element in the education system, are expected to develop various creative, innovative, and effective learning strategies so that the learning process can proceed optimally and improve the quality of student learning (Linda Zuliana et al., 2021).

Mathematics is a subject that plays a crucial role in the education system. Not only does it function as the study of numbers, patterns, and relationships between concepts, but it also plays a role in developing logical, critical, systematic, and analytical thinking skills. Therefore, mathematics learning aims to equip students with various mathematical skills that can be applied in everyday life and in solving various problems.

One important skill that needs to be developed in mathematics learning is problem-solving ability. Problem-solving ability is an individual's ability to understand a problem, design a solution strategy, implement that strategy systematically, and evaluate the results. This ability is crucial because in everyday life, students are often faced with various situations that require critical and analytical thinking skills to find appropriate solutions to problems (Lalu & Baiq, 2021).

In mathematics learning, there are several topics that students often find difficult, one of which is quadratic equations. Quadratic equations are a crucial topic in global mathematics learning and are a fundamental part of the secondary school curriculum. This topic plays a significant role because it provides the foundation for understanding more complex mathematical concepts and serves as an introduction for students to study various fields in science, technology, engineering, and mathematics (STEM) (In'am et al., 2024). Furthermore, the concept of quadratic equations is also widely used in various scientific fields such as physics, economics, and engineering. However, various studies show that many students still experience difficulties in understanding the concept and solving problems related to quadratic equations.

Research conducted by (Mathonsi & Rankhumise, 2025) showed that students' frequent errors in solving quadratic equations were related to errors in algebraic manipulation and a lack of understanding of the problem-solving steps. Furthermore, research by (Baybayon & Lapinid, 2024) also found that students frequently made errors when using the quadratic formula and performing mathematical calculations correctly.

Another study by (Wahyuningtyas et al., 2025) also showed that students' difficulties in solving quadratic equations were not only caused by mathematical calculation errors but also by a lack of understanding of the basic concepts of quadratic equations themselves. This situation indicates that the mathematics learning process still needs improvement so that students can understand mathematical concepts more deeply and not just memorize solution formulas.

These problems indicate the need for efforts to improve the quality of mathematics learning so that students can better understand concepts and develop mathematical problem-solving skills. One such effort is to implement a learning model that encourages active student involvement in the learning process.

One learning model that can be used is the problem-solving model. This learning model emphasizes students' thinking processes in understanding problems, planning solution strategies, implementing the designed strategies, and evaluating the results. Through the application of the problem-solving learning model, students are expected to develop critical and analytical thinking skills and improve their problem-solving abilities in mathematics learning.

In addition to using appropriate learning models, the use of learning media also plays a crucial role in supporting the mathematics learning process. One such media is the Student Worksheet (LKPD). LKPD is a learning medium designed to help students understand material through structured learning activities, thus facilitating independent conceptual discovery.

Research conducted by (Lestari & Hidayati, 2025) shows that the use of E-LKPD based on problem-based learning can improve students' mathematical problem-solving skills and help them understand the steps to solving problems more systematically. Furthermore, research conducted by (Teapon et al., 2025) also shows that the use of worksheets based on problem-solving steps can improve students' reflective thinking skills in solving mathematics problems.

Based on these various research findings, it can be concluded that students' difficulties in solving quadratic equations need to be addressed through the application of appropriate learning models and the use of learning media that effectively support the learning process.

Therefore, this study aims to conduct a literature review on the various difficulties experienced by students in solving quadratic equations and analyze the application of the problem-solving learning model assisted by student worksheets (LKPD) in improving students' mathematical problem-solving abilities.

METHODS

This research uses a literature review method. This method is carried out by tracing, identifying, reviewing, evaluating, and interpreting various previously published research results. Through this approach, the researcher systematically reviewed various scientific articles and journals by following the research stages that have been designed. Literature review focuses on efforts to understand and solve a problem through a review of various relevant written sources. This approach is also descriptive because it aims to collect and integrate information related to the research topic to provide a comprehensive picture. In this study, the literature review was conducted to examine and analyze various sources related to students' problem-solving abilities through the use of learning media. The literature review process was carried out systematically through three main stages: planning, conducting, and reporting (Kabar, 2023).

RESULTS AND DISCUSSION

Students' Difficulties in Solving Quadratic Equations

Quadratic equations are one of the important topics in mathematics learning because they have numerous applications in various scientific fields such as physics, engineering, economics, and computer science. This concept is frequently used to represent mathematical relationships that involve quadratic relations between variables. Therefore, a proper understanding of quadratic equations is essential for students as a foundation for studying more advanced mathematical topics in higher levels of education (Kizi, 2026).

However, several studies indicate that many students still encounter various difficulties in understanding quadratic equations. These difficulties are not only related to computational errors but also to the lack of understanding of fundamental algebraic concepts that underlie the process of solving quadratic equations. Some students experience difficulties in identifying the general form of quadratic equations, determining the roots of the equation, and understanding the relationship between coefficients and the solutions of the equation (Mathonsi & Rankhumise, 2025).

Students' errors in solving quadratic equations can be analyzed using several error analysis approaches. One commonly used approach in mathematics education research is Newman Error Analysis. This approach examines students' errors through several stages, including reading the problem, understanding the problem, transforming the problem into mathematical form, performing the calculation process, and writing the final answer. Research findings show that the most common errors occur in the stages of understanding the problem and transforming the problem into an appropriate mathematical model (Babale et al., 2024).

Furthermore, students' difficulties also arise when they are confronted with contextual mathematical problems. In such situations, many students struggle to connect the concept of quadratic functions with real-life situations, which makes them unable to construct appropriate mathematical models that represent the given problems (Díaz et al., 2020).

These difficulties are also supported by other studies which indicate that many students still make both conceptual and procedural errors when solving quadratic equations. These errors include incorrect use of formulas, mistakes in algebraic manipulation, and the inability to follow systematic problem-solving procedures (Javillonar, 2024).

In addition, broader literature reviews regarding quadratic equation research in mathematics education reveal that this topic continues to be an important focus in educational studies. Many researchers attempt to identify students' learning difficulties and develop various instructional strategies that can improve students' understanding of quadratic equation concepts (Kabar, 2023).

Problem Solving Model in Learning Quadratic Equations

One of the instructional approaches that can be applied to overcome students' difficulties in understanding quadratic equations is the problem solving learning model. This learning model emphasizes students' ability to analyze problems, design solution strategies, implement these strategies, and evaluate the obtained solutions. Through these stages, students are expected to construct a deeper conceptual understanding of the mathematical material (Lestari & Hidayati, 2025).

The application of the problem solving model in mathematics learning also provides opportunities for students to develop critical and creative thinking skills. This is important because mathematics learning does not only emphasize computational skills but also focuses on conceptual understanding and the ability to apply mathematical knowledge in various situations (Meriza et al., 2022).

Nevertheless, the effectiveness of the problem solving model in mathematics learning is also influenced by the teaching strategies used by teachers. Learning practices that are still teacher-centered and emphasize the direct use of formulas without providing adequate conceptual understanding may cause students to experience difficulties when dealing with problems that vary in form and level of complexity (Kim How et al., 2022).

Moreover, identifying students' errors in solving quadratic equations is an important step in the learning process. Through error analysis, teachers can better understand the types of difficulties experienced by students and subsequently design more effective learning strategies that support students in understanding quadratic equation concepts (Wahyuningtyas et al., 2025).

The Role of Media and LKPD in Learning Quadratic Equations

In addition to appropriate learning models, the use of instructional media also plays an important role in supporting mathematics learning. Learning media can help transform abstract mathematical concepts into more concrete representations, making them easier for students to understand.

Besides instructional media, the use of Problem Solving-based Student Worksheets (LKPD) can also support students in following systematic problem-solving steps. LKPD is designed to guide students through the stages of understanding problems, planning solution strategies, implementing the solutions, and evaluating the results obtained. Thus, the learning process becomes more structured and meaningful for students (Teapon et al., 2025).

Furthermore, meta-analysis studies show that the use of teaching aids and instructional media in mathematics learning has a positive effect on students' mathematical problem-solving abilities. Properly designed learning media can increase students' engagement in the learning process and help them develop a deeper understanding of mathematical concepts (Widodo et al., 2025).

Based on the results of various previous studies, it can be concluded that many students still experience difficulties in solving problems related to quadratic equations. These difficulties are associated with several factors, such as limited understanding of fundamental concepts, errors in performing algebraic manipulations, and inaccuracies in applying formulas when solving given problems. In addition, several studies indicate that students' mistakes frequently occur at the stage of understanding the problem as well as in the process of translating the problem into an appropriate mathematical model.

Furthermore, several research findings reveal that the implementation of appropriate learning strategies, such as the use of the problem-solving learning model, along with the utilization of instructional media such as student worksheets (LKPD) and mathematical teaching aids, can contribute positively to improving students' conceptual understanding and mathematical problem-solving abilities, particularly in the topic of quadratic equations.

CONCLUSION

This study establishes that the persistent difficulties faced by students in solving quadratic equation problems are closely related to weaknesses in conceptual comprehension, limitations in interpreting mathematical problems, and the absence of structured problem-solving processes in learning activities. Addressing these issues requires an instructional approach that emphasizes analytical reasoning, conceptual exploration, and systematic solution procedures within mathematics learning. The problem-solving learning model supported by Student Worksheets (LKPD) provides a coherent instructional framework that guides students through the stages of understanding problems, formulating

strategies, implementing solutions, and evaluating results. This structured learning process strengthens students' mathematical reasoning and promotes deeper conceptual understanding of quadratic equations.

The importance of this study lies in its contribution to the development of more effective mathematics learning practices that focus on enhancing students' problem-solving competence. The findings highlight the necessity for teachers to adopt learning models and instructional media that actively involve students in meaningful mathematical exploration. The integration of a problem-solving learning model with LKPD therefore offers a practical pedagogical strategy for improving students' mathematical problem-solving abilities and supporting more effective and conceptually oriented mathematics instruction.

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