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ANALYSIS OF THE DEEP LEARNING APPROACH TO MATHEMATICAL PROBLEM-SOLVING SKILLS AMONG EIGHTH-GRADE STUDENTS

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ABSTRACT

Mathematical problem-solving is a fundamental competency that should be fostered through mathematics instruction, as it enables students to interpret, analyze, and solve various problems systematically. Despite its importance, many students still encounter difficulties in selecting appropriate solution strategies and evaluating the accuracy of their solutions. This study aimed to examine the mathematical problem-solving skills of eighth-grade students following the implementation of the deep learning approach based on Polya's problem-solving framework. A descriptive qualitative design was employed, and the study was conducted at a junior high school in Karawang Regency, Indonesia, during the second semester of the 2025/2026 academic year. The participants consisted of 41 eighth-grade students. Data were collected through classroom observations, teacher interviews, documentation, and a mathematical problem-solving test. The findings revealed that the deep learning approach created an engaging learning environment that promoted students' active participation through discussion, collaboration, question-and-answer activities, and group presentations. The analysis further indicated that most students were able to understand the given problems, develop appropriate solution strategies, and implement the planned procedures correctly. However, some students continued to experience difficulties during the looking back stage because they rarely reflected on or verified both the solution process and the final results. Overall, the findings suggest that the deep learning approach provides meaningful, contextual, and reflective learning experiences that contribute to the development of students' mathematical problem-solving skills. Therefore, this approach has the potential to serve as an effective instructional alternative for strengthening mathematical problem-solving skills in mathematics education.

Keywords: deep learning approach; mathematical problem solving; mathematics learning

ABSTRAK

Kemampuan pemecahan masalah matematis merupakan kompetensi penting yang perlu dikembangkan dalam pembelajaran matematika karena membekali siswa dengan kemampuan memahami, menganalisis, dan menyelesaikan berbagai permasalahan secara sistematis. Meskipun demikian, masih banyak siswa yang mengalami kesulitan dalam menentukan strategi penyelesaian yang tepat serta melakukan refleksi dan verifikasi terhadap hasil yang diperoleh. Penelitian ini bertujuan mendeskripsikan kemampuan pemecahan masalah matematis siswa kelas VIII melalui penerapan pendekatan pembelajaran mendalam yang mengacu pada tahapan pemecahan masalah menurut Polya. Penelitian ini menggunakan metode deskriptif kualitatif dan dilaksanakan di salah satu sekolah menengah pertama di Kabupaten Karawang pada semester genap tahun ajaran 2025/2026 dengan melibatkan 41 siswa kelas VIII sebagai subjek penelitian. Data dikumpulkan melalui observasi, wawancara dengan guru, dokumentasi, serta tes kemampuan pemecahan masalah matematis. Hasil penelitian menunjukkan bahwa penerapan pendekatan pembelajaran mendalam mampu menciptakan *proses pembelajaran yang lebih interaktif sehingga mendorong siswa untuk berpartisipasi aktif melalui kegiatan diskusi, kolaborasi, tanya jawab, dan presentasi hasil kerja. Analisis kemampuan pemecahan masalah matematis memperlihatkan bahwa sebagian besar siswa telah mampu memahami permasalahan, menyusun strategi penyelesaian, serta melaksanakan langkah-langkah penyelesaian secara tepat. Namun, sebagian siswa masih mengalami kesulitan pada tahap pengecekan kembali (looking back) karena belum terbiasa melakukan refleksi dan memverifikasi proses maupun hasil penyelesaian yang telah diperoleh. Temuan penelitian ini menunjukkan bahwa pendekatan pembelajaran mendalam mampu memberikan pengalaman belajar yang bermakna, kontekstual, dan reflektif sehingga mendukung perkembangan kemampuan pemecahan masalah matematis siswa. Dengan demikian, pendekatan pembelajaran mendalam berpotensi menjadi salah satu alternatif pembelajaran yang efektif untuk meningkatkan kemampuan pemecahan masalah matematis dalam pembelajaran matematika.*

Kata kunci: *pembelajaran mendalam; kemampuan pemecahan masalah matematis; pembelajaran matematika*

Introduction

The objectives of mathematics education extend beyond helping students acquire conceptual knowledge; they also include developing learners' ability to address mathematical challenges successfully across diverse contexts (Riyani & Hadi, 2023). Among the competencies emphasized in mathematics learning, mathematical problem-solving skills play a crucial role because they enable students to interpret problems, formulate solution plans, implement appropriate strategies, and assess the validity of the outcomes obtained (Lestari et al., 2024). According to Polya (1971), the problem-solving process consists of four interconnected stages, namely understanding the problem, planning a solution, executing the plan, and reviewing the result. These skills are regarded as fundamental goals of mathematics education because they contribute to the development that requires logical, critical, systematic, and innovative thinking needed to deal with mathematical and everyday-life problems (Wahyuni et al., 2024).

For eighth-grade students, mathematical problem-solving skills are particularly important because they are entering a developmental stage marked by a gradual shift from concrete reasoning to more abstract and formal modes of thinking. Mathematical problem-solving is a fundamental competency that involves conceptual understanding, procedural reasoning, and technical accuracy. Students' learning styles and learning experiences influence how they interpret problems, formulate strategies, and construct appropriate mathematical solutions (Ningrum et al., 2025). At this level, students are expected to interpret information accurately, recognize relationships among mathematical concepts, and independently solve contextual problems of increasing complexity. Moreover, the junior secondary mathematics curriculum emphasizes not only conceptual understanding but also the practical application of mathematical knowledge in everyday contexts. Consequently, strengthening students' problem-solving abilities is essential for supporting cognitive growth and preparing them for more advanced mathematical studies.

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Mathematical problem-solving proficiency among Indonesian students is still considered relatively low (Siswanto & Meiliasari, 2024). According to the PISA 2022 results, the mathematical literacy achievement of Indonesian students remained below the international average (OECD, 2023). Similar concerns have been highlighted in recent studies, which indicate that mathematical problem solving continues to be a major challenge because many learners struggle to formulate solution strategies and verify the correctness of their answers (Rott et al., 2021). These findings suggest that students frequently encounter difficulties when dealing with tasks that require higher-order thinking and contextual reasoning (Azira et al., 2025). In addition, mathematics instruction is often characterized by teacher-centered practices that emphasize procedural learning and formula memorization rather than conceptual understanding (Padang et al., 2023). Consequently, many students encounter challenges when solving non-routine problems that demand analytical thinking, planning, and evaluation (Rahmawati et al., 2023).

Another challenge concerns the implementation of innovative teaching approaches in classroom settings. Teachers frequently face constraints such as limited instructional time, variations in students' learning abilities, and pressure to complete curriculum content. These factors often encourage the continued use of teacher-centered instruction. Consequently, students have limited opportunities to build their own understanding, participate in collaborative learning, and reflect on their learning experiences. These conditions emphasize the need for instructional approaches that provide meaningful learning experiences and can be effectively implemented in authentic classroom settings.

The preliminary observations conducted in this study revealed similar concerns. Analysis of students' responses indicated that 31 of the 41 participants (75.61%) correctly identified both the given information and the questions presented. However, only 13 students (31.71%) successfully developed appropriate strategies for solving the given problems. These findings suggest that students encounter more challenges during the devising a plan and looking back stages of Polya's problem-solving framework. Therefore, a more comprehensive investigation is needed to better understand students' performance at each stage of the mathematical problem-solving process.

Overcome these challenges, mathematics learning should provide meaningful experiences that actively involve students in constructing their own understanding (Afidati & Malasari, 2023). One instructional approach that has recently received considerable attention is the deep learning approach (Anwar & Sodik, 2025). In the context of this study, deep learning refers to an educational approach rather than an artificial intelligence technique. This approach emphasizes meaningful learning experiences, active engagement, knowledge integration, and reflective thinking (Mystakidis, 2021). Its principles align closely with meaningful learning theory, which emphasizez that effective learning occurs when new information is linked to learners existing knowledge and previous esperiences. Through such learning experiences, students are encouraged to construct meaning, integrate concepts, and reflect on their learning processes. As a result, students are expected to develop not only procedural competence but also a deeper conceptual understanding that can be applied across various mathematical contexts.

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Previous studies have reported positive effects of the deep learning strategy in mathematics education. Bambang et al (2025) found that this approach increased students' participation and engagement during mathematics learning activities. Likewise Idris et al (2025) reported that deep learning supported the development of critical thinking and mathematical problem-solving ability. Students frequently encounter conceptual, procedural, and computational errors while solving mathematical problems, indicating that meaningful learning should emphasize conceptual understanding and reflective thinking instead of memorizing formulas or algorithms (Astriyani et al., 2020). Although these studies demonstrated beneficial outcomes, most of them focused primarily on learning achievement, engagement, or critical thinking. Developing students' mathematical problem-solving skills requires learning environments that encourage conceptual understanding, critical thinking, and active engagement with authentic problems rather than relying solely on procedural instruction. Problem-Based Learning (PBL) has been widely recognized as an effective approach to fostering these competencies through meaningful learning activities (Darojah et al., 2025). The integration of Android-based learning media with Problem-Based Learning provides interactive and contextual learning experiences that support students in exploring mathematical concepts independently and solving real-world mathematical problems more effectively (Sugiharti et al., 2025). Research specifically examining mathematical problem-solving skills through Polya's four-stage framework within the context of deep learning, particularly among eighth-grade students, remains limited. Furthermore, previous studies have provided little explanation regarding how the characteristics of the deep learning approach contribute to each stage of Polya's problem-solving process.

Overall, existing research suggests that meaningful, active, and reflective learning experiences can enhance students' conceptual understanding and foster higher-order thinking skills. Nevertheless, most investigations have concentrated on general cognitive outcomes rather than providing detailed descriptions of students' problem-solving performance at each stage of Polya's framework. This limitation indicates the need for further research exploring how the deep learning approach facilitates students' engagement throughout the entire problem-solving process.

Based on these considerations, a research gap remains regarding students solve mathematical problem at each level of Polya's framework when learning is conducted through a deep learning approach. Unlike previous studies, the present research specifically focuses on describing eighth-grade students' mathematical problem-solving skills according to Polya's four stages within the implementation of deep learning. Therefore, this study aims to analyze the mathematical problem-solving skills of eighth-grade students through the application of the deep learning approach based on Polya's problem-solving framework.

Research Methods

To examine students' mathematical problem-solving skills in the context of deep learning, this study was conducted using a qualitative descriptive approach. The selection of this design was based on the purpose of the study, which was to obtain a detailed description of students' problem-solving abilities and learning

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experiences rather than to examine causal relationships or test statistical hypotheses. Through a qualitative perspective, the researcher was able to investigate students' performance at each stage of Polya's problem-solving framework in greater depth

The research was implemented in one junior high school in Karawang Regency, Indonesia, during the second semester of the 2025/2026 academic year. The sample comprised 41 eighth-grade students who were purposively selected based on the objectives of the study. The participants were chosen because they had participated in mathematics instruction that applied the deep learning approach and therefore met the criteria required for this study. The class consisted of 20 male students and 21 female students aged between 13 and 14 years. All participants had previously learned mathematical content relevant to the topics investigated in this research.

Data were gathered using several techniques, including classroom observation, semi-structured interviews, documentation, and mathematical problem-solving tests. Observation activities were carried out during the learning process to examine students' involvement, interaction, cooperation, and engagement while participating in learning activities. Interviews were conducted with the mathematics teacher to obtain supporting information related to students' learning characteristics, classroom conditions, and difficulties encountered in mathematical problem solving. Each interview session lasted approximately 15–30 minutes. Supporting documents such as lesson plans, photographs of classroom activities, and students' written work were also collected. Following the learning process, a mathematical problem-solving test was administered to evaluate students' abilities across Polya's four stages of problem solving.

This study employed four research instruments: observation sheets, interview protocols, documentation records, and a mathematical problem-solving test. The observation sheets were used to document students' learning activities, including active participation, collaboration, questioning, discussion, and reflection throughout the implementation of the deep learning approach. Interview protocols were utilized to gather supplementary information from the mathematics teacher concerning students' learning conditions and the challenges experienced during the instructional process. Documentation records were collected to provide supporting evidence and strengthen the credibility of the research findings. In addition, the mathematical problem-solving test was constructed according to Polya's four problem solving: understanding the problem, devising a plan, carrying out the plan, and looking back. Before being delivered to the participants, the exam was evaluated and validated by two mathematics education experts to ensure that its content was appropriate and aligned with the aims of the study.

The research procedure was conducted in three stages: preparation, implementation, and final stages. During the preparation stage, the researcher identified the research problem, prepared lesson plans, and developed research instruments. During the implementation stage, mathematics learning was conducted using the deep learning approach over four meetings. In the first meeting, students explored contextual problems and identified important information related to the learning material. In the second meeting, students collaboratively developed solution strategies and discussed alternative approaches. In the third meeting, students implemented the solution strategies and presented their findings. In the fourth meeting, students reflected on their answers, evaluated solution procedures, and completed the mathematical problem-solving test. Classroom observations and documentation activities were carried out throughout the learning process. At the end of the implementation stage, interviews were conducted with the mathematics teacher. During the final stage, all collected data were organized, analyzed, interpreted, and used to draw conclusions.

To improve the credibility of the findings, technique triangulation was employed. Information obtained from observations, interviews, documentation, and mathematical problem-solving tests was compared and verified to ensure consistency across different sources. Findings identified through one data collection technique were confirmed using evidence obtained from the others. For instance, difficulties demonstrated by students in the problem-solving test were examined further through observation results, interview data, and supporting documentation.

Sugiyono (2023) interactive model, which includes data reduction, data display, and conclusion drawing, was used to analyze the data. Observation data were evaluated to detect patterns of student participation and learning behavior during the execution of the deep learning approach. Interview data were processed through coding and categorization procedures to identify themes associated with students' mathematical problem-solving skills and learning characteristics. Documentation data were reviewed to support and strengthen evidence obtained from observations and interviews. Additionally, Polya's four steps were used to analyze students' answers to the mathematical problem-solving examination in order to characterize their capacity to comprehend issues, create plans, put solution techniques into practice, and assess outcomes. The findings received from these sources were subsequently merged to provide a full description of students' mathematical problem-solving skills.

Results and Discussion

4.1 Results

This research was conducted over four meetings using the deep learning approach in an eighth-grade class at SMP Negeri 4 Klari. During the learning process, students were presented with contextual problems related to daily life and worked collaboratively in groups to solve the given problems. Observation results showed that students became more active throughout the learning activities. Students were observed discussing, asking questions, exchanging ideas, and trying to determine appropriate solutions to the given problems. This increased participation occurred because contextual learning activities encouraged students to connect prior knowledge with mathematical concepts encountered in everyday life. Consequently, students found it easier to understand mathematical concepts and actively engage in the learning process. This increased engagement not only reflects students' active participation but also indicates an initial development of conceptual understanding, as students began to relate mathematical ideas to contextual situations. This learning activity is illustrated in Figure 1.

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Figure 1. Student Activities During Group Discussions Using the Deep Learning Approach

Figure 1 illustrates students' active participation during group discussions. Students exchanged ideas, discussed solution strategies, and collaborated with their peers to solve contextual mathematical problems. These observations indicate that deep learning approach created opportunities for students to become actively involved in constructing their own understanding instead of relying solely on information delivered by the teacher. The learning process is further illustrated in Figure 2.

Figure 2. Student Activities During Presentation Sessions

Figure 2 shows students presenting their discussion results in front of the class. This activity provided opportunities for students to communicate mathematical ideas, explain their reasoning, and build confidence in expressing their opinions.

Additionally, students appeared more enthusiastic about participating in learning activities compared to previous lessons. Students confidently expressed their opinions and explained the results of their group discussions in front of the class. Students' engagement in discussion activities, presentations, and problem-solving demonstrates that the implementation of the deep learning approach provides opportunities for students to actively participate in constructing their own understanding.

Based on the analysis of students' answer sheets, mathematical problem-solving skills demonstrated variable levels of performance across Polya's four indicators. Most pupils were able to understand challenges and choose appropriate solution options. However, some students were still found to experience difficulties in checking their answers.

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Based on Table 1, most students demonstrated satisfactory performance in understanding problems and devising solution strategies. However, several students still encountered difficulties during the looking back stage because they did not review their solution procedures and final answers. These findings indicate that students have developed fundamental mathematical problem-solving skills, although their reflective abilities still require improvement. The results described above are summarized in Table 1.

Table 1. Results of Eighth-Grade Students' Mhatematical Problem-Solving Skills

Problem-Solving Indicators	**Results**
Understanding the problem	Most students were able to identify the known and required information correctly.
Devising a Plan	Most students were able to determine appropriate strategies to solve the problems.
Carrying Out the Plan	Students were able to implement the strategies they had developed, although several calculation errors were still found.
Looking Back	Some students did not recheck their work, resulting in errors in the final answers.

The variation in students' performance across Polya's stages suggests that while cognitive skills improved, metacognitive regulation was not yet fully developed, particularly in the final checking stage. Students' work also showed that most students were able to understand the given problems and determine appropriate solution strategies. However, some students did not recheck their calculations or verify the accuracy of their solutions during the looking back stage, resulting in errors in their final answers. Representative examples of students' work are presented in Figure 3.

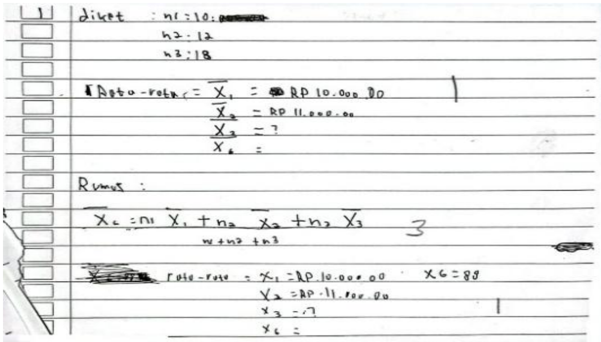

Figure 3. A Student's Response Before the Implementation of the Deep Learning Approach

Based on Figure 3, the student succeeded in recognizing the given data and what was being asked, as well as formulating a suitable strategy to solve it. However, the student encountered difficulties in carrying out the planned solution, resulting in an incorrect final answer. In addition, there was no evidence that the student reviewed or verified the obtained result. This indicates that although the student successfully completed the understanding the problem and devising a plan stages, difficulties remained in carrying out the plan and looking back stages of

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Polya's mathematical problem-solving process. A student's response after the implementation of the deep learning approach is presented in Figure 4.

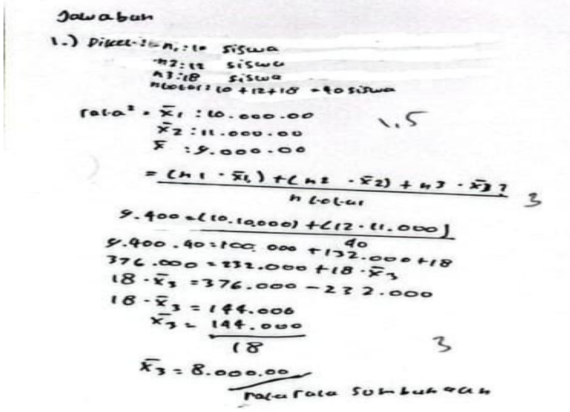

Figure 4. A Student's Response After the Implementation of the Deep Learning

Based on Figure 4, the student was able to understand the problem, determine an appropriate solution strategy, and successfully carry out the planned solution. The student obtained the correct final answer. However, there was no evidence that the student reviewed the calculation process or verified the obtained result, indicating that the looking back stage had not yet been carried out.

4.2 Discussion

The findings indicate that the implementation of the deep learning approach provides students with active, meaningful, and contextual learning experiences. During the learning process, students participated in group discussions, expressed opinions, asked questions, and presented their solutions in front of the class. This active engagement enabled students to construct conceptual understanding independently and connect mathematical concepts to real-life situations.

Figure 3 illustrates students' mathematical problem-solving performance before the implementation of the deep learning approach, whereas Figure 4 presents an example of students' work after the implementation. A comparison of these examples indicates that students showed improvement in understanding the problem, devising a solution strategy, and carrying out the plan after participating in deep learning activities. Nevertheless, some students still experienced difficulties in the looking back stage because they did not review or verify their final answers.

These findings are consistent with Nurjannah & Ramlah (2025), who reported that the deep learning approach positively influences mathematical problem-solving skills through active, reflective, collaborative, and contextual learning. Similarly, Slamet et al (2025) explained that deep learning positions students as active agents who construct knowledge independently and develop deeper conceptual understanding. These findings reinforce the results of the present study, indicating that the deep learning approach supports students in understanding mathematical concepts more meaningfully than instruction that primarily emphasizes content delivery.

The use of contextual problems also helped students connect mathematical concepts with situations encountered in daily life (Sa'diah & Nahdi, 2023). Through real-life problems, students found it easier to understand why specific mathematical concepts and procedures should be applied to solve a problem (Barumbun &

Kharisma, 2022). Such meaningful learning experiences strengthen students' conceptual understanding and facilitate the application of mathematical knowledge in various situations. The characteristics of the deep learning approach, which emphasize meaningful learning, active participation, knowledge integration, and reflection, further support this process (Mystakidis, 2021). This process encourages students to activate prior knowledge, integrate multiple mathematical concepts, and apply reasoning to unfamiliar situations, thereby strengthening their mathematical problem-solving performance.

Besides enhancing students' conceptual understanding, the deep learning approach promoted greater student involvement throughout the learning activities. Students participated more actively in discussions, raised questions, shared their ideas, and worked collaboratively with their classmates. This finding reflects a transition from a teacher-centered learning environment to a more student-centered approach. Similar results were reported by Asmarawati (2026), who found that deep learning activities characterized by collaboration, experiential learning, and technology integration could improve students' participation in mathematics classrooms. Through active engagement, students were provided with opportunities to construct their own understanding, leading to more meaningful and lasting learning outcomes. Furthermore, increased participation not only enhanced classroom involvement but also supported students' mathematical achievement, as actively engaged learners tended to understand problems more accurately, choose suitable solution strategies, and apply mathematical concepts in a systematic manner.

During the devising a plan and carrying out the plan stages, most students were able to determine appropriate solution strategies and implement them effectively. They demonstrated the ability to recognize relevant mathematical concepts, organize solution procedures in a logical sequence, and apply accurate calculation methods. These findings indicate that students not only understood mathematical concepts at the theoretical level but were also capable of transferring this knowledge to solve mathematical problems successfully. This result is consistent with the findings of Musaidah et al (2024), who reported that the deep learning approach enhances students' mathematical problem-solving skills by promoting systematic problem analysis, integrating related mathematical concepts, and selecting appropriate solution strategies. Furthermore, the approach supports the development of higher-order thinking skills that are fundamental to effective mathematical problem solving. From a cognitive perspective, deep learning encourages learners to actively process information and construct meaningful relationships among mathematical concepts. Pedagogically, collaborative learning creates opportunities for students to exchange ideas, justify their reasoning, and deepen their conceptual understanding through interactions with their peers.

However, some students still experienced difficulties during the looking back stage. Based on the analysis of students' responses in Figure 4, students tended to write down final answers immediately without reviewing their solution procedures or calculations. Consequently, some students overlooked calculation errors, while others obtained correct answers without verifying their solution procedures or final results. This finding indicates that students' reflective abilities still need improvement. According to Polya, as cited in Sari et al (2024), the looking back stage

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is essential because it helps students identify errors, verify the accuracy of their answers, and strengthen their understanding of the solution process. This difficulty may be attributed to students' prior learning habits, which tend to emphasize obtaining final answers rather than evaluating solution processes. Consequently, students have not yet developed systematic self-monitoring and reflective habits during mathematical problem solving.

The outcomes of this research align with earlier studies showing that the deep learning approach plays a role in strengthening higher-order thinking skills. According to Dahroni et al (2025) deep learning promotes the growth of critical, creative, reflective, and problem-solving competencies through learning experiences that are meaningful to students. Likewise, Pujawati et al (2025) revealed that deep learning is capable of enhancing students' mathematical critical thinking by prompting them to investigate conceptual connections, undergo reflective thinking, and relate their knowledge to authentic contexts. Such findings correspond with those of the current study, confirming that applying the deep learning approach fosters improvement in both students' mathematical problem-solving skills and their critical thinking abilities.

This study presents both strengths and limitations. One notable strength is that the deep learning approach provides meaningful, contextual, and collaborative learning experiences that facilitate the development of students' mathematical problem-solving skills. Furthermore, the use of Polya's four-stage framework enables a more comprehensive analysis of students' performance at each stage of the problem-solving process. Nevertheless, several limitations should be acknowledged. Some students continued to encounter difficulties during the looking back stage because they were more concerned with obtaining the correct final answer than with reviewing and evaluating the accuracy of their solution procedures. In addition, the study involved only one eighth-grade class from a single school, which restricts the extent to which the findings can be generalized to other contexts. Another limitation relates to the duration of the implementation, which was limited to four meetings. Consequently, the long-term impact of the deep learning approach cannot be fully determined. The sustainability of the observed improvements may depend on consistent implementation, adequate teacher guidance, and ongoing opportunities for students to participate in reflective learning activities.

This study offers empirical insights into mathematics education by demonstrating the ways in which the characteristics of the deep learning approach promote the development of students' mathematical problem-solving skills. Meaningful learning experiences help students understand problems more effectively, while knowledge integration supports the process of developing solution plans. Active participation encourages students to implement solution strategies, and reflective activities strengthen their ability to evaluate the accuracy of their answers. In addition, the findings offer practical implications for mathematics teachers, curriculum developers, and educational policymakers. Mathematics teachers are encouraged to incorporate structured reflection activities, such as self-assessment questions and evaluation checklists, to enhance students' metacognitive abilities. Curriculum developers may consider integrating reflective learning components into mathematics learning objectives, whereas educational policymakers can support professional development initiatives that promote active, meaningful, and reflective learning practices. Therefore, the deep learning approach can be considered a promising alternative for improving students' mathematical problem-solving skills.

Conclusion and Suggestion

The results of this study reveal that applying the deep learning approach creates meaningful, learner-centered experiences that contribute to strengthening students' mathematical problem-solving competence. The majority of students demonstrated the ability to comprehend problems, formulate solution strategies, and execute their solutions correctly in line with the stages of Polya's problem-solving model. Nevertheless, a number of students continued to face challenges at the looking-back stage, as they neglected to review their procedures and verify their final answers. Accordingly, the deep learning approach may serve as a viable instructional alternative for fostering the growth of students' mathematical problem-solving abilities.

It is recommended that teachers offer students greater opportunities to participate in reflective practices, particularly with regard to checking and assessing their own solutions. Subsequent studies could involve a wider range of participants and explore the application of the deep learning approach in connection with other mathematical competencies, including critical thinking, reasoning, and creativity.

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