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The Application of Deep Learning Approaches in Mathematics Learning: A Literature Review Study

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Abstract

Mathematics learning often faces challenges such as monotonous and teacher-centered methods, which can reduce student interest and motivation. The Deep Learning approach offers an innovative alternative by positioning students as active subjects in the learning process. This approach emphasizes in-depth understanding through three main pillars: Mindful Learning, Meaningful Learning, and Joyful Learning. The study employed a Systematic Literature Review (SLR) method by analyzing eight empirical articles published between 2021–2025 related to the implementation of the Deep Learning approach in mathematics learning. The finding indicate that the Deep Learning approach can foster in-depth conceptual understanding. In addition, this approach can also improve the quality of learning by making students the main subjects and actively involved during the learning process. This study is expected to provide a comprehensive overview for educators and researchers in designing adaptive and effective mathematics learning in the 21st-century education era.

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INTRODUCTION

Learning is a structured activity designed by educators involving interactions between teachers, students, and various learning resources (Kusmaryono & Wijayanti, 2025). Learning is considered successful when its objectives have been achieved. In reality, however, the modern learning process faces numerous challenges. Several issues can hinder the success of educational goals; for instance, a common problem is monotonous, teacher-centered instruction. This results in a lack of student interaction with their learning environment, leading students to lose interest and develop a dislike for certain subjects. One subject frequently disliked by students is mathematics (Kusmaryono et al., 2022). Mathematics is a field of study that explores patterns, structures, change, space, and the concept of numbers (Hayati & Jannah, 2024).

Educators must be able to understand students' learning styles and the appropriate approaches to be applied in the learning process. One approach that can transform students' perspective on mathematics lessons is the Deep Learning approach. The Deep Learning approach fosters deep understanding through learning activities centered on students (Syafi'i, 2025). Student-centered learning can serve as a key strategy to enhance the quality of the learning process (Ramadani et al., 2025). Students tend to become more active and motivated in seeking new discoveries. Learning that positions students as the central focus of the educational process can stimulate their curiosity about new concepts. As reported on the website smk.kemendikdasmen.go.id, which features a news article

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titled "Education Minister Emphasizes the Role of Deep Learning in Improving the Quality of Indonesian Education" (February 13, 2025), in which Minister Abdul Mu'ti described Deep Learning as an approach aimed at comprehensive understanding not merely rote memorization through the integration of critical thinking, problem-solving, and collaboration (Lestari, 2025). According to Patmaniar et al. (2025), the application of the Deep Learning approach can foster innovation and inclusivity in mathematics learning.

The Deep Learning approach emphasizes three conceptual pillars (Khotimah & Abdan, 2025). The first pillar is Mindful Learning. Mindful learning refers to the background characteristics that influence students' learning processes. Students have different characteristics and learning styles. Therefore, educators need to understand these differences and design appropriate and applicable approaches to support the success of the teaching and learning process. The second pillar is Meaningful Learning, which refers to a learning process that is significant and purposeful. Learning activities should leave a positive impression so that the knowledge delivered can be well received by students. The third pillar is Joyful Learning, which refers to creating an enjoyable learning experience. Educators must design learning activities that involve students so that the teaching and learning process becomes more engaging and enjoyable. Enjoyable learning can also increase students' motivation in learning activities.

Based on the three pillars above, it can be concluded that educators must understand the unique character and way of thinking of each student. The approaches implemented should be capable of encouraging students to think critically and participate actively during learning activities. Furthermore, creating an enjoyable learning environment should also be considered, as this can foster student enthusiasm for creating, processing, and developing their own findings. Suherman et al. (2025) state that these three pillars can enhance student motivation through interaction during the learning process. Students can engage in discussions, ask questions, and apply their knowledge in mathematics learning activities, thereby training their higher-order thinking skills.

Kholid et al. (2025) conducted literature documenting research on deep learning with a focus on conceptual understanding of mathematics. This underscores that the focus of deep learning lies not solely on the final outcome, but rather on how students logically construct connections between concepts. Meanwhile, Rahayu et al. (2025) examined Indonesian Realistic Mathematics Education within the framework of deep learning. Rosiyati et al. (2025) investigated the deep learning approach with a focus on the Merdeka Curriculum. However, these studies remain generally theoretical in nature; thus, further research is needed that focuses on the dynamics of real-world implementation of the deep learning approach within mathematics classrooms.

In the 21st century, education has become a crucial field of study. To support global advancement, meaningful and in-depth learning approaches are required. This aligns with the concept of the Deep Learning approach. The Deep Learning approach offers learning that emphasizes deeper conceptual understanding. This approach implements learning by applying academic material to everyday life. It helps students develop critical and systematic thinking patterns. The purpose of this literature review is to examine the influence of the Deep Learning approach on mathematics learning, with a focus on cognitive abilities and mathematics content. This study is interesting to explore because the approach being examined is relatively new in the field of education. The results of this review are expected to provide insights for educators and policy researchers

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in designing and implementing mathematics learning that is more effective, adaptive, and relevant to the needs of modern education.

METHOD

This study aims to analyze the influence of the Deep Learning approach in mathematics learning using the systematic literature review method. A systematic literature review is a critical and systematic review process of scientific works, books, articles, and other sources relevant to a specific research topic (Alif, 2023). In preparing this article, the researcher conducted several stages, namely identification, screening, eligibility, and inclusion. Before conducting the research, the researcher formulated the research questions. The questions in this study are: 'What are the impacts of implementing the Deep Learning approach on students?', 'Which cognitive ability is most frequently studied?', and 'What is the most dominant mathematics material?'.

The first stage is identification. In this literature study, the researcher utilized 'Mendeley Search' on January 16, 2026. Unlike Mendeley's role as a Reference Manager, Mendeley Search does not rely on a single traditional database. Instead, it utilizes its own crowdsourced catalog of research papers, built and enriched by its user community. This is highly beneficial for readers as it allows them to discover a broader and more relevant literature review with ease. The search keywords used for this study were in Indonesian: '*pendekatan deep learning'* and '*pembelajaran matematika'* (mathematics learning), which yielded 68 articles. This was followed by the second stage, screening, which was adjusted based on the inclusion and exclusion criteria listed in Table 1.

Table 1. Inclusion and Exclusion

Inclusion	Exclusion
Research investigating the application of the deep learning approach in mathematics learning	Application of the deep learning approach outside mathematics learning
2021-2025	Outside this year range
Students from Elementary (SD), Junior High (SMP), and Senior High (SMA) schools	University students, teachers, and training programs
Empirical research with a clear design	Conceptual articles, opinions, or literature reviews

The third stage is eligibility. Each article's quality is verified using predetermined criteria. The collected articles are evaluated based on the inclusion and exclusion criteria listed in Table 1. As a result of the inclusion and exclusion screening process, eight relevant articles were identified for further analysis. The next stage is inclusion. Articles that meet the inclusion criteria are retained, while those that do not are excluded. Data that meet the inclusion criteria are analyzed and presented descriptively. After analyzing the articles, the final stage is drawing conclusions. The results of the data analysis must be able to answer the research questions.

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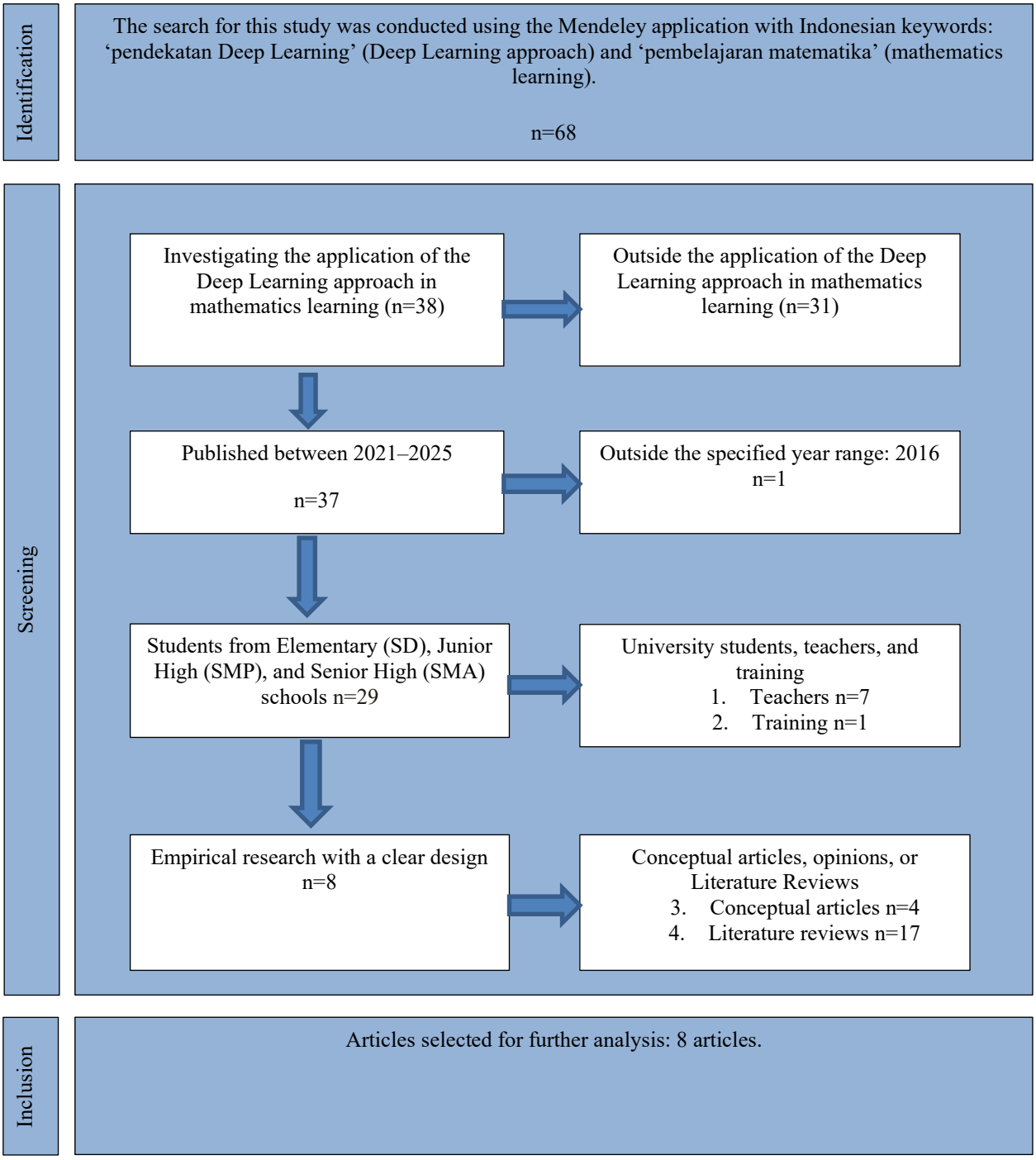

Figure 1. PRISMA Diagram

The obtained research yielded diverse discussions. In the search stage, using the Mendeley application with the Indonesian keywords "*Pendekatan* Deep Learning" and "*Pembelajaran Matematika*" resulted in 68 articles. Subsequently, the articles were screened using inclusion and exclusion criteria, producing 8 articles. These articles were then analyzed further.

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Data from these articles were subsequently processed using content analysis techniques. The articles were analyzed by focusing the synthesis on aspects of students' cognitive abilities and the specifications of the mathematics material. The findings were systematically categorized to map the influence of deep learning implementation on learning outcomes across various educational levels.

RESULT AND DISCUSION

Based on the results obtained, the researcher identified articles related to the improvement of students' cognitive abilities and mathematics subject matter. Strengthening the understanding of basic concepts serves as the primary foundation. This is demonstrated by Hayati & Monaliza (2025) in Grade V elementary geometry, which resulted in student enthusiasm, active engagement, and comprehensive mastery of the material. Similarly, Siregar et al. (2025) found that using interactive GeoGebra media in vocational high school (SMK) trigonometry effectively deepened conceptual mastery. Mutmainnah (2025) further confirms these findings in elementary arithmetic, where active involvement through simulations led to more meaningful conceptual understanding. Meanwhile, Kinasih et al. (2025) reported an improvement in understanding statistical operations among Grade IV students through the integration of urban farming.

In terms of critical thinking, Luthfiyah et al. (2025) demonstrated the transformation of plane geometry learning into an interactive experience that enhances students' in-depth analysis and original ideas. Meanwhile, Slamet et al. (2025) revealed that, from high school students' perspectives, Deep Learning facilitates holistic geometry processing through sharper spatial representations. Both studies focus on geometry content and demonstrate improvements in critical thinking skills.

Furthermore, regarding the strengthening of problem-solving skills and higher-order thinking, Bariroh (2025) highlighted the significant influence of the Problem Based Learning model in algebra, which fosters active learning oriented toward complex analytical abilities. These cognitive skills contribute to a mathematics learning environment that is progressive, holistic, and overall positively impactful.

The final point focuses on the improvement of students' cognitive learning outcomes. Anggraini et al. (2025) state that a mathematics teaching module based on the Deep Learning approach can serve as a solution to students' low cognitive achievement. This is evidenced by the fact that the Deep Learning approach is deemed capable of increasing students' learning motivation and interest during the learning process using the teaching module on geometry material.

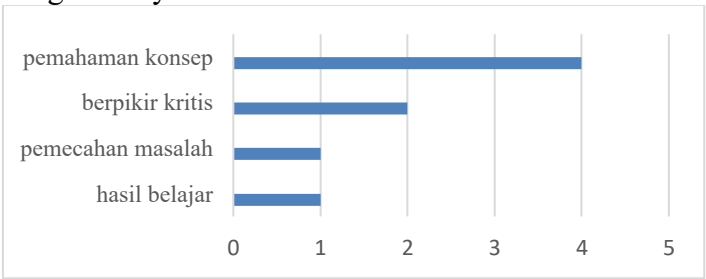

Figure 2. Distribution of Cognitive Ability Focus

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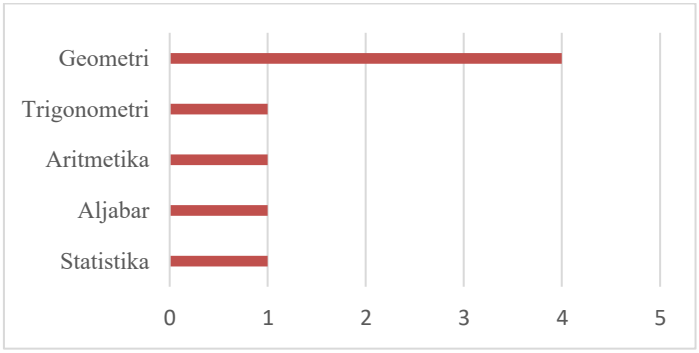

Figure 3. Distribution of Material Focus

The results from the 8 articles above indicate that 4 of them focused on conceptual understanding ability, 2 on critical thinking, 1 on problem-solving, and 1 on students' learning outcomes. The fact that the majority of the articles discuss conceptual understanding signifies that Deep Learning has successfully transformed the way students learn. Instead of merely memorizing formulas, students are now directed to understand the meaning behind the material, so that the knowledge acquired is more deeply ingrained and meaningful. This proves that the Meaningful Learning pillar is the aspect most frequently measured for its success. Beyond discussing students' cognitive abilities, the articles also explain the mathematics topics that served as the research subjects. Geometry was the most frequently discussed material, featuring in 4 studies. This is likely due to the characteristics of geometry material, which require strong spatial visualization, a need that can be effectively facilitated through the Deep Learning approach and interactive media such as GeoGebra. In addition to geometry, trigonometry, arithmetic, algebra, and statistics were each represented by 1 article, indicating a research gap for future studies.

The implementation of the Deep Learning approach in mathematics learning has proven to be relevant to the demands of 21st-century education, which emphasizes higher-order thinking skills (Kholid et al., 2025). This statement is supported by research findings indicating that the Deep Learning approach is capable of improving students' cognitive abilities. Furthermore, the integration of the Joyful Learning and Mindful Learning pillars addresses the challenges of traditional learning, which is often monotonous. By creating an enjoyable and student-centered learning atmosphere, this approach not only improves cognitive learning outcomes but also fosters active engagement, which is an essential skill in the modern education era.

CONCLUSION

The results of this systematic literature review show that the application of Deep Learning in mathematics learning plays an important role in fostering a deep conceptual understanding in students. This approach encourages students not only to memorize procedures but also to understand the meaning, relationships between concepts, and reflect on their thinking processes. The Deep Learning approach has been proven effective in improving the quality of mathematics learning by emphasizing deep conceptual understanding, active student engagement, and a pleasant learning atmosphere. By combining the pillars of Mindful, Meaningful, and Joyful Learning, this approach addresses the weaknesses of traditional learning which is often rote and unengaging. The implementation of this approach can develop students' conceptual

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understanding, critical thinking, and problem-solving skills, making it an important solution in facing the dynamics of modern education and the needs of today's students.

However, research examining the influence of the Deep Learning approach on students' numeracy skills is still lacking. Statistical material is also a topic that is minimally studied. The scarcity of this research is likely due to the Deep Learning approach which is still relatively new in education, and the tendency for statistics instruction to remain procedural. This creates opportunities for future research to contribute new insights in mathematics education literature. This research needs to be conducted to address the low numeracy skills of students and provide new innovations in student-centered learning methods to shape their thinking through statistical material in everyday life applications. Such research is expected to contribute significantly to enriching literature on the influence of the Deep Learning approach at the school level, although currently, the scope is still limited to the analysis of national-scale articles. Therefore, it is recommended for further research to expand the scope of literature by including references from international databases.

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