The Effectiveness of Problem-Based Learning and Base Ten Blocks Media on Understanding Addition and Subtraction Concepts in Primary Schools: A Systematic Literature Review

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Abstract
This study aims to synthesise findings regarding the effectiveness of Problem-Based Learning (PBL) and Base Ten Blocks in improving primary school pupils' conceptual understanding of addition and subtraction. The method used was a Systematic Literature Review (SLR) employing the PRISMA approach. A literature search via Google Scholar and SINTA yielded 55 articles; following a selection process, 40 articles were identified for full review, and 15 articles met the inclusion criteria for analysis. The results of the study indicate that PBL tends to enhance active engagement and conceptual understanding through contextual problem-solving, whilst Base Ten Blocks are effective in facilitating the visualisation of place value and arithmetic operations. The integration of both approaches shows a tendency towards a more optimal impact compared to their separate use. Thus, the combination of PBL and concrete materials has the potential to support meaningful mathematics learning, although further empirical research is required to strengthen these findings.
Keywords: *Problem Based Learning Base Ten Blocks, concept understanding, addition and subtraction, primary school.*

Abstrak
Penelitian ini bertujuan mensintesis temuan terkait efektivitas *Problem Based Learning* (PBL) dan media *Base Ten Blocks* dalam meningkatkan pemahaman konsep penjumlahan dan pengurangan siswa sekolah dasar. Metode yang digunakan adalah *Systematic Literature Review* (SLR) dengan pendekatan PRISMA. Penelusuran literatur melalui Google Scholar dan SINTA menghasilkan 55 artikel, kemudian melalui tahap seleksi diperoleh 40 artikel untuk ditelaah penuh, dan 15 artikel memenuhi kriteria inklusi untuk dianalisis. Hasil kajian menunjukkan bahwa PBL cenderung meningkatkan keterlibatan aktif dan pemahaman konsep melalui pemecahan masalah kontekstual, sedangkan *Base Ten Blocks* efektif membantu visualisasi konsep nilai tempat dan operasi hitung. Integrasi keduanya menunjukkan kecenderungan dampak yang lebih optimal dibandingkan penggunaan secara terpisah. Dengan demikian, kombinasi PBL dan media konkret berpotensi mendukung pembelajaran matematika yang bermakna, meskipun diperlukan penelitian empiris lanjutan untuk memperkuat temuan ini.
Kata kunci: Pembelajaran Berbasis Masalah, Blok Dasar Sepuluh, pemahaman konsep, penjumlahan dan pengurangan, sekolah dasar.

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INTRODUCTION

Mathematics is a fundamental subject at primary level as it plays a vital role in developing reasoning skills, logical thinking and problem-solving abilities from an early age. The teaching of mathematics in primary schools aims not only to enable pupils to perform calculations, but also to ensure they understand the concepts underlying each arithmetic operation so that they can apply them flexibly in various everyday contexts. Conceptual understanding forms the cornerstone of mathematics learning because mathematical concepts are hierarchical and interrelated; consequently, a failure to grasp foundational concepts will lead to difficulties in learning subsequent material (Marliana, Sunaryo, & Zamnah, 2023).

One of the core mathematical competencies that is crucial to the learning success of primary school pupils is the ability to add and subtract whole numbers. These arithmetic operations form the foundation for mastering more advanced mathematical operations such as multiplication and division. However, various research findings indicate that pupils' ability to understand the concepts of addition and subtraction remains relatively low. Pupils are often able to solve problems procedurally, but do not yet understand the meaning of the operations being performed, particularly those relating to the concepts of the ones, tens and hundreds places. Common errors include mistakes in the process of carrying and borrowing, as pupils have not yet grasped the conceptual relationship between place values (Manek, 2023).

This issue is inextricably linked to the nature of mathematics teaching in primary schools, which still tends to be teacher-centred and emphasises the use of symbols and the mechanical solving of exercises. This abstract approach to learning is ill-suited to the cognitive development stage of primary school pupils, who are still at the concrete operational stage. At this stage, pupils require learning experiences involving real objects to be able to build an understanding of abstract mathematical concepts (Manek, 2023).

When learning does not provide students with the opportunity to manipulate and represent numbers concretely, conceptual understanding does not develop optimally. Theoretically, this aligns with the constructivist perspective, which emphasises that knowledge is actively constructed by learners through interaction with their environment and meaningful learning experiences. In the context of mathematics learning, conceptual understanding cannot be achieved merely through the rote memorisation of algorithms, but rather through the process of problem exploration, conceptual representation, and reflection on the solution strategies employed. Therefore, a learning model is required that can encourage student engagement in constructing knowledge and linking mathematical concepts to real-life situations.

One learning model that aligns with this principle is Problem-Based Learning (PBL). PBL uses contextual problems as the starting point for learning, thereby encouraging students to think critically, engage in discussion, and develop conceptual understanding independently. The findings of Marliana et al. (2023) indicate that the implementation of PBL has a positive impact on students' mathematical conceptual understanding, as students not only learn procedures but also understand the reasoning and underlying concepts behind problem-solving. In mathematics education, PBL enables addition and subtraction to be studied as tools for solving real-world problems, rather than merely symbolic operations.

Nevertheless, the implementation of PBL will be more effective if supported by the use of learning materials suited to the characteristics of primary school pupils. Concrete materials play a vital role in helping pupils visualise abstract concepts, particularly the concept of place value and arithmetic operations. One of the concrete materials widely recommended in mathematics education is Base Ten Blocks, or Dienes blocks. This material is designed to represent the base-ten number system through the physical manipulation of units, tens, and hundreds. Manek's (2023) research demonstrates that the use of Dienes blocks can improve pupils' mathematics learning outcomes in the area

of whole number addition, as pupils are able to understand the concept of place value in a more concrete manner.

Similar findings were also reported by Abu Bakar et al. (2025), who stated that Base Ten Blocks are effective in improving mastery of the concept of subtraction with regrouping, particularly as this resource helps pupils understand the regrouping process visually and through hands-on manipulation. Thus, Base Ten Blocks serve not only as a counting aid but also as a cognitive tool for building a deeper conceptual understanding of addition and subtraction operations.

Furthermore, Qoiriyah et al. (2024) assert that mathematics teaching that combines problem-based learning with concrete materials provides a more meaningful learning experience. The integration of PBL and concrete materials enables pupils to explore problems, test solutions, and verify results directly through the manipulation of real objects. This combination helps to connect mathematical concepts, procedures, and representations holistically, thereby fostering a stronger and more sustainable development of students' conceptual understanding.

Although various studies have examined the implementation of Problem-Based Learning (PBL) and the use of Base Ten Blocks in primary school mathematics education, the findings reveal considerable variation. These differences are evident in the research designs employed, such as experiments, classroom action research, and descriptive studies, resulting in conclusions that are not always consistent. Furthermore, the diverse research contexts, in terms of student characteristics, year groups, and learning environments also influence the results obtained.

On the other hand, some studies have focused more on the effectiveness of PBL or the use of Base Ten Blocks separately, and thus have not yet provided a complete picture of the potential of integrating the two to improve understanding of the concepts of addition and subtraction. To date, there have been few studies that have systematically integrated and synthesised these various findings to arrive at comprehensive and structured conclusions.

The lack of a comprehensive literature review makes it difficult to obtain an overview of the trends in effectiveness, strengths and limitations of each approach. Therefore, a Systematic Literature Review (SLR) is required to systematically, transparently, and evidence-based integrate various research findings to provide a more comprehensive understanding of the effectiveness of Problem-Based Learning and Base Ten Blocks in primary school mathematics education.

Based on the above, this study aims to systematically examine: (1) the effectiveness of implementing Problem-Based Learning in improving primary school pupils' conceptual understanding of addition and subtraction; (2) the role of Base Ten Blocks in reinforcing conceptual understanding of basic arithmetic operations; and (3) the effectiveness of integrating Problem-Based Learning and Base Ten Blocks in building meaningful and sustainable understanding of the concepts of addition and subtraction.

METHOD

This study employed a Systematic Literature Review (SLR) method using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure that the processes of literature identification, selection, evaluation and synthesis were conducted in a systematic, transparent and replicable manner. The literature search was conducted across several scientific databases, namely Google Scholar and SINTA, using a combination of the keywords Problem-Based Learning, PBL, Base Ten Blocks, Dienes Blocks, manipulative media, addition, subtraction, conceptual understanding, and elementary school. The use of Boolean operators (AND and OR) aimed to broaden the scope of the search whilst maintaining the relevance of the retrieved articles.

Based on the results of the initial search, a total of 55 articles were identified, comprising 5 articles from Google Scholar and 50 articles from SINTA. In the initial stage, irrelevant articles were removed prior to the screening process, resulting in 10 articles being eliminated and 45 articles remaining for the screening stage. Subsequently, the screening process, involving a review of titles and abstracts, resulted in 5 articles being excluded, leaving 40 articles to proceed to the next stage.

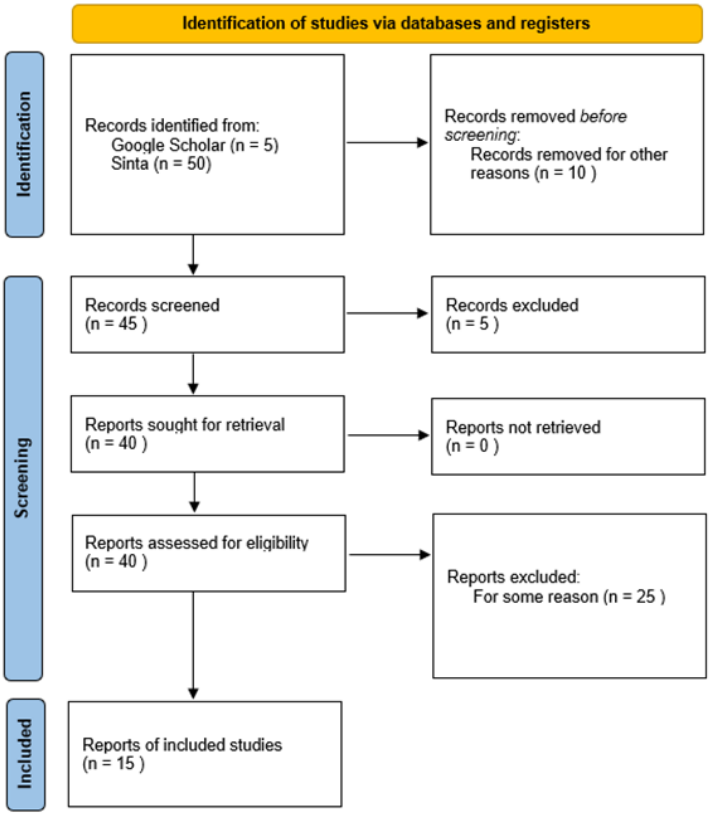
During the retrieval stage, all articles were successfully accessed, meaning that no articles could not be downloaded (reports not retrieved = 0). Subsequently, a full-text assessment was carried out on 40 articles, resulting in 25 articles being excluded as they did not meet the inclusion criteria. Consequently, the final number of articles meeting the criteria and used in the analysis was 15. The entire process followed the PRISMA flowchart, which includes the identification, screening, eligibility assessment, and inclusion stages, thereby ensuring the transparency and traceability of the research.

The inclusion criteria for this study encompass empirical research articles and systematic reviews that discuss the implementation of Problem-Based Learning and/or the use of Base Ten Blocks or similar concrete materials, focusing on addition and subtraction or basic arithmetic operations, involving primary school pupils, and published within the last ten years (2015–2025). Meanwhile, the exclusion criteria include articles that are opinion pieces, conceptual essays, do not present sufficient empirical data, or are not relevant to the focus of the study.

To ensure the quality of the literature analysed, a quality appraisal was conducted on each article using several indicators, namely the clarity of the research objectives, the appropriateness of the methodological design, the validity and reliability of the data, and the clarity of the results and discussion. Each article was then categorised as high, medium, or low quality, and only articles of medium and high quality were included in the synthesis process.

Data from the selected articles were systematically extracted, recording key information such as authors and year of publication, research design, subject characteristics, the learning models used, types of learning media, and the main findings relating to the understanding of addition and subtraction concepts. Data analysis was conducted using thematic synthesis techniques through the stages of open coding, axial coding and selective coding. In the open coding stage, the researcher identified the main findings from each article; the axial coding stage was used to group the findings into related categories; whilst the selective coding stage aimed to formulate the main themes, namely the effectiveness of Problem-Based Learning, the role of Base Ten Blocks, and the integration of both in improving the understanding of basic arithmetic operations.

Consequently, all stages of this research were systematically organised and aligned with the PRISMA guidelines to produce a comprehensive, valid and scientifically sound literature review.



Picture 1. SLR using the PRISMA method

RESULTS AND DISCUSSION

Based on the literature selection process using the PRISMA approach, a total of 55 articles were identified in the initial identification stage, comprising 5 articles from Google Scholar and 50 articles from SINTA. Following the initial elimination of 10 irrelevant articles, 45 articles remained and proceeded to the screening stage. At this stage, the titles and abstracts were reviewed, resulting in the elimination of 5 articles as they did not align with the research focus, leaving 40 articles to proceed to the full-text assessment stage.

All articles at that stage were successfully accessed (none could not be downloaded), so the process continued with a comprehensive evaluation of the content. Of the 40 articles analysed in full, 25 were excluded as they did not meet the inclusion criteria, whether in terms of topic relevance, research subject, or data completeness. Consequently, 15 final articles that met the criteria were identified and used as the basis for analysis in this study.

The fifteen articles cover a range of research designs, such as classroom action research, experiments, descriptive studies and literature reviews, which generally focus on the application of Problem-Based Learning (PBL), the use of concrete materials such as Base Ten Blocks or Dienes blocks, and the integration of both in teaching addition and subtraction in primary schools. This variety of research designs indicates that studies on this topic have been conducted using a range of methodological approaches, thereby providing diverse perspectives on understanding the effectiveness of learning interventions.

When analysed thematically, the findings from these 15 articles reveal a consistent pattern. Firstly, Problem-Based Learning serves as a pedagogical approach capable of enhancing student engagement in the learning process, encouraging critical thinking,

and helping students understand the concepts of addition and subtraction through contextual problem-solving. Secondly, the use of Base Ten Blocks has proven effective in helping students visualise the concepts of place value and arithmetic operations in a concrete manner, thereby reducing the conceptual errors that frequently occur during the borrowing and carrying processes.

Furthermore, the results of the study indicate that the integration of Problem-Based Learning and Base Ten Blocks yields more optimal outcomes than the use of either approach in isolation. This combination enables pupils not only to understand the calculation procedures but also to explain the mathematical significance of each step taken. Consequently, learning becomes more meaningful as pupils simultaneously link contextual problems with concrete and symbolic representations.

To clarify the characteristics and contributions of each of the articles analysed, a summary of the research findings is presented in Table 1. The table contains information on the authors, the focus of the research, the methods used, and the main contributions to the understanding of the concepts of addition and subtraction.

Table 1. Summary of Relevant Literature

No	Author	Research Focus	Method
1	Oktapiana, E., et al. (2025)	Understanding the concepts of addition and subtraction of whole numbers	Descriptive
2	Komsiyah, S. (2024)	Using Dienes blocks to improve addition and subtraction skills	Teacher action research
3	Fasza, D. F., et al. (2024)	Applying the PBL model to improve learning outcomes in whole number calculations	Classroom action research
4	Qoiriyah, M., et al. (2024)	Improving calculation skills through the PBL model with concrete media	Collaborative classroom action research
5	Harahap, U. K., et al (2024)	Applying the PBL model to improve addition and subtraction calculation skills	Library research
6	Ardanari, M. S., et al (2024)	PBL model to improve competence in mathematics subtraction	Classroom action research
7	Khuzaima, A., et al. (2024)	Improving addition and subtraction skills through PBL strategies	Classroom action research
8	Wahyuni & Suyoto (2024)	Analysis of students' learning difficulties in understanding addition and subtraction	Qualitative descriptive
9	Marliana, P., et al. (2023)	The effect of the PBL model on students' mathematical concept comprehension	Quantitative experiments
10	Kartini, I., et al. (2023)	Implementation of PBL to improve students' concept comprehension	Library research
11	Manek, H. (2023)	Improving students' mathematics learning outcomes by using Dienes blocks in teaching integer addition	Classroom action research
12	Sutrisnowati, N. A., et al. (2024)	Dienes block media assisted by mathematical worksheet to improve students learning outcomes	Teacher action research

No	Author	Research Focus	Method
13	Silveira, E. (2021)	A study on the indications to the use of base ten blocks and green chips in mathematics textbooks	Library research
14	Wijianto, B., et al. (2024)	Improving understanding of the concepts building cubes and blocks using the project based learning	Classroom action research
15	Bakar, A. A. A., et al. (2025)	Base ten blocks in refusal reassembling students with learning problems	Classroom action research

Based on the overall results of the analysis, it can be concluded that improvements in primary school pupils' understanding of the concepts of addition and subtraction are influenced not only by the learning model or the media used in isolation, but by the synergy between the two. These findings reinforce the importance of using active and contextual learning approaches supported by concrete media to help pupils develop a deeper and more sustainable understanding of mathematical concepts.

CONCLUSION

Based on the results of a Systematic Literature Review (SLR) using the PRISMA approach on 15 selected articles, it can be concluded that Problem-Based Learning (PBL) and the use of Base Ten Blocks make a significant contribution to supporting the understanding of addition and subtraction concepts among primary school pupils. A synthesis of the findings indicates that PBL acts as a pedagogical approach that encourages active student engagement, the development of critical thinking skills, and conceptual understanding through contextual problem-solving. On the other hand, Base Ten Blocks serve as an effective concrete medium in helping pupils visualise the concepts of place value and arithmetic operations, thereby minimising conceptual errors.

Furthermore, the findings of the study indicate that the integration of Problem-Based Learning and Base Ten Blocks tends to yield more optimal results than the application of each method in isolation. This combination facilitates a connection between concrete learning experiences and abstract thinking processes, thereby enabling students to develop a deeper and more meaningful understanding of mathematical concepts.

However, the findings of this review also indicate variations in research design, learning contexts and the characteristics of the participants in the studies analysed. Therefore, the results of this systematic literature review are not intended to make absolute generalisations, but rather to provide a comprehensive overview of trends regarding the effectiveness of PBL and Base Ten Blocks in primary school mathematics education.

Based on these findings, it is recommended that mathematics teaching practices in primary schools consider the use of problem-based learning models supported by concrete materials as a strategy to enhance conceptual understanding. Furthermore, future research is recommended to empirically examine the integration of Problem-Based Learning and Base Ten Blocks using a more robust experimental design and diverse contexts, in order to strengthen the findings obtained through this literature review.

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