Circle: Jurnal Pendidikan Matematika
Vol. 6, No. 1, March 2026, pp. 67 – 77
P-ISSN: 2776-6268; E-ISSN: 2777-1008

Piaget's Cognitive Theory in Upper Primary School Students' Mathematical Problem Solving: A Literature Review

Suyanto [1*], Stevanus Budi Waluya [2], Isnaini Rosyida [3], Isnarto [4], Ary Woro Kurniasih [5]
[1]STKIP Sinar Cendekia, Indonesia
[2,3,4,5] Universitas Negeri Semarang, Indonesia
* Corresponding Author: *yanto@stkipsinarcendekia.ac.id*

ARTICLE INFO

Article History:
Received: 03 July 2025
Revised: 12 March 2026
Accepted: 25 March 2026

Keywords:
concrete operational stage
literature review
mathematical problem solving
piaget's cognitive theory

ABSTRACT

Mathematical problem-solving ability are one of the key competencies in mathematics education and a major requirement of the global curriculum. Mathematical problem-solving ability are one of the key competencies in mathematics education and a major requirement of the global curriculum. This study aims to systematically examine the implementation of Jean Piaget's cognitive development theory in mathematical problem solving in upper primary school mathematics learning. The method used was a literature review of articles published between 2020 and 2025 through the Google Scholar, Scopus, and ScienceDirect databases. The search and selection process was carried out through stages of identification, screening, and feasibility assessment based on predetermined inclusion and exclusion criteria, resulting in 19 articles that were analysed using descriptive qualitative methods. The synthesis results show four main findings. First, the characteristics of the concrete operational stage are an important foundation in designing mathematics problem-solving learning. Secondly, the processes of assimilation and accommodation in Piaget's theory play a role in helping students construct conceptual understanding through the use of concrete and semi-concrete representations. Third, innovative learning approaches such as Problem-Based Learning and the use of manipulatives are effective in developing students' problem-solving strategies. Fourth, the implementation of Piaget's theory had a positive impact on learning engagement, logical thinking skills, and the quality of mathematics learning. The main contribution of this study is to present a conceptual synthesis that integrates Piaget's stages of cognitive development with mathematical problem-solving processes, as well as emphasising the importance of aligning learning designs with the cognitive characteristics of upper primary school students. These findings provide a theoretical basis for the development of more contextual, exploratory, and student-centred mathematics learning.

Kata kunci:
pemecahan masalah matematika
tahap operasional kongkrit
teori kognitif Piaget
tinjauan literatur

Kemampuan pemecahan masalah matematika merupakan salah satu kompetensi penting dalam pembelajaran matematika dan menjadi tuntutan utama kurikulum global. Penelitian ini bertujuan untuk secara sistematis mengkaji implementasi teori perkembangan kognitif Jean Piaget dalam pemecahan masalah matematika dalam pembelajaran matematika sekolah dasar atas. Metode yang digunakan adalah tinjauan literatur tehadap artikel yang diterbitkan antara tahun 2020 dan 2025 melalui database Google Scholar, Scopus, dan ScienceDirect. Proses pencarian dan seleksi dilakukan melalui tahapan identifikasi, penyaringana, serta penilaian kelayakan berdasarkan kriteria inklusi dan eksklusi yang telah ditetapkan, sehingga menghasilkan 19 artikel yang dianalisis secara kualitatif deskriptif. Hasil sintesis menunjukkan empat temua utama. Pertama, karakteristik tahap operasional konkret menjadi landasan penting dalam merancang pembelajaran pemecahan masalah matematika. Kedua, proses asimilasi dan akomodasi dalam teori Piaget berperan membantu siswa membangun pemahaman konsep melalui penggunaan representasi konkret dan semi-konkret. Ketiga, pendekatan pembelajaran inivatif seperti Problem-Based Learnig dan penggunaan manipulatif, efektif dalam

mengembangkan strategi pemecahan masalah siswa. Keempat, implementasi teori Piaget berdampak positif terhadap keterlibatan belajar, kemampuan berpikir logis, dan kualitas pembelajaran matematika. Kontribusi utama penelitian ini adalah menyajikan sintesis konseptual yang mengintegrasikan tahap perkembangan kognitif Piaget dengan proses pemecahan masalah matematika, serta menekankan pentingnya kesesuaian desain pembelajaran dengan karakteristik kognitif siswa sekolah dasar atas. Temuan ini memberikan landasan teoretis bagi pengembangan pembelajaran matematika yang lebih kontekstual, eksploratif, dan berpusat pada siswa.

How to Cite:
Suyanto. S., Waluya. S. W., Rosyida, I., Isnarto. I., & Kurniasih, A. W. (2026). Piaget's Cognitive Theory in Upper Primary School Students' Mathematical Problem Solving: A Literature Review. *Circle: Jurnal Pendidikan Matematika, 6*(1), 67-77. https://doi.org/10.28918/circle.v6i1.2605

https://doi.org/10.28918/circle.v6i1.2605

INTRODUCTION

The rapid development of science and technology today cannot be separated from the important role of mathematics as a basic science that supports various aspects of life (Omar et al., 2024). To that end, mathematics is taught progressively from primary education to higher education (Susanti et al., 2020; Suyanto, 2023). Particularly at the primary education level, mathematics learning not only develops numeracy skills, but also fosters logical, systematic and critical thinking skills, equipping pupils to deal with everyday problems.

One of the important competencies in mathematics learning is the ability to solve mathematical problems. This competency is one of the key 21st-century skills and a globally recognised learning curriculum requirement necessary for dealing with various complex situations in real life (Midgett & Eddins, 2001; Herold-Blasius, 2024). Problem-solving ability involve the process of understanding problems, planning strategies for resolution, implementing those strategies, and evaluating the solutions obtained logically and systematically in accordance with the stages of Polya's theory (Kaitera & Harmoinen, 2022). Through this process, students not only master mathematical procedures for finding answers, but also develop deeper mathematical thinking skills (Pehkonen et al., 2023).

However, facts on the ground show that the mathematical problem-solving abilities of upper primary school students are still relatively low. Students often have difficulty understanding problems, choosing the right solution strategy, and connecting mathematical concepts to contextual situations (Kaitera & Harmoinen, 2022). This situation indicates that mathematics learning in upper primary school needs to be improved so that students' thinking skills can develop optimally.

The low level of students' mathematical problem-solving abilities is not only influenced by internal factors, but also caused by external factors, particularly the quality of learning designed by teachers, which causes students to experience difficulties in learning mathematics (Umar Sa'ad et al., 2014). One factor that influences the success of mathematics learning is the suitability of learning strategies to the cognitive development stage of students (Agustyaningrum et al., 2022; Anggraita et al., 2024).

Among the various theories of cognitive development, Jean Piaget's theory is particularly relevant to the developmental stage of students because it provides a fundamental basis for understanding how students construct mathematical knowledge. According to Piaget, upper primary school pupils are at the concrete operational stage, which is a stage of cognitive development in which conceptual understanding can develop through direct interaction with objects in real contexts, direct experience, and visual representation (Maiyah et al., 2023). To that end, mathematics learning at this stage should involve exploratory activities, the use of concrete media, and learning situations that enable students to actively construct knowledge (Ozkale & Aprea, 2023). Therefore, solving mathematical problems is not viewed as a mechanical activity, but rather as a cognitive process that is in line with students' intellectual development (Putri et al., 2024). Thus, Piaget's theory helps students' thinking processes occur cognitively when solving problems.

Previous studies have shown that applying Piaget's principles in primary school mathematics education, most of these studies still focus on applying Piaget's theory to specific learning strategies, the use of manipulative media, or implementation in specific mathematical topics (Maiyah et al., 2023). This study also tends to highlight the effectiveness of activity-based approaches or the use of concrete representations in improving students' understanding of mathematical concepts. However, studies that systematically synthesise the relationship between these two aspects, namely Piaget's cognitive development theory and primary school students' mathematical problem-solving abilities, are still relatively limited.

Based on these limitations, there appears to be a gap. Firstly, there has not been much research that comprehensively integrates concepts in Piaget's theory, such as the concrete operational stage, assimilation, and accommodation, into the framework of mathematical problem-solving analysis. Secondly, most studies are still contextual in nature, so conceptually they do not yet describe how Piaget's theory can be used as a pedagogical basis for designing mathematics problem-solving learning in upper primary schools. Thirdly, research identifying patterns of Piaget's theory implementation in mathematical problem solving is still limited.

Based on this gap, a literature review is needed to examine the relationship between Piaget's cognitive development theory and the mathematical problem-solving abilities of primary school students. By synthesising relevant research, it is hoped that a more comprehensive conceptual understanding can be gained of how Piaget's theoretical principles can be implemented in mathematics learning to support the development of students' problem-solving abilities. The purpose of this study is to analyse and synthesise research findings on the implementation of Piaget's cognitive development theory in solving mathematical problems among upper primary school students.

METHOD

This study uses *a literature review* method to systematically examine the implementation of Jean Piaget's cognitive psychology theory in mathematical problem solving in upper primary school mathematics learning. This method enables researchers to comprehensively identify, analyse, and synthesise previous research findings to gain a conceptual understanding of the relationship between Piaget's cognitive development theory and mathematical problem-solving learning.

In this *literature review*, articles were selected through a structured search and selection process, which included identifying literature sources, screening based on titles and abstracts, and assessing eligibility based on predetermined inclusion and exclusion criteria. The search for articles was limited to the period 2020–2025 to ensure that the literature analysed reflected the latest developments in research on the application of Piaget's theory in mathematics education. The search process used scientific databases, namely Google Scholar, Scopus, and ScienceDirect, as well as the Publish or Perish application. Keywords used in the search process: "Piaget's cognitive theory" AND "mathematical problem solving" OR "mathematical problem solving" AND "primary school mathematics learning" OR "upper primary school". Keyword combinations were used to obtain articles directly related to Piaget's theory and mathematical problem solving in the context of primary school learning.

The article selection process involves several stages. The first stage of identification is to collect all articles obtained from the search results in the database used. The second stage of screening involves selecting articles based on their titles and abstracts to ensure their relevance to the research focus. The third stage of eligibility assessment involves reading the article in greater depth to ensure that it meets the inclusion criteria for the study.

The articles obtained were then selected based on the following inclusion criteria: (1) an article discussing Jean Piaget's cognitive psychology theory, (2) articles examining mathematical problem solving in mathematics education, (3) research subjects in upper primary school, (4) articles published in national and international journals. Irrelevant articles were excluded from the study.

The selection process resulted in 19 articles that met the inclusion criteria and were relevant to the research objectives. The articles were then analysed further to identify patterns of research findings related to the implementation of Piaget's theory in mathematics problem-solving learning.

Data analysis was conducted through descriptive qualitative synthesis. At this stage, each article was examined to identify key concepts, learning approaches used, and research findings related to the application of Piaget's theory in mathematics learning. Subsequently, these findings were coded and grouped based on thematic similarities.

Based on this analysis, four main themes were identified that describe the pattern of Piaget's theory implementation in mathematics learning, namely: (1) characteristics of the concrete operational stage in upper primary school students; (2) the role of assimilation and accommodation processes in mathematics learning, (3) learning strategies that support the development of mathematical problem-solving abilities, and (4) implications of applying Piaget's theory to students' problem-solving abilities.

The results of this thematic synthesis were then used to explain the relationship between Piaget's cognitive development theory and the process of mathematical problem solving in mathematics learning in upper primary schools.

RESULTS AND DISCUSSION

Research Results

The results of the analysis of selected articles show that the implementation of Jean Piaget's cognitive development theory in upper primary school mathematics learning is associated with an increase in students' mathematical problem-solving abilities. The results of the literature synthesis found the following four themes:

1) Characteristics of Piaget's concrete operational stage in primary school pupils

   Most of the selected articles indicate that upper primary school students (aged 9–12 years) are still predominantly at the concrete operational stage according to Piaget's theory of cognitive development. At this stage, pupils begin to think logically, but still rely heavily

on concrete experiences, real objects, and visual representations to understand mathematical concepts. Various studies show that students' difficulties in solving mathematical problems often occur when learning places too much emphasis on symbols and abstractions without the support of concrete experiences. (Zhou & Brown, 2015; Ozkale & Aprea, 2023; Anggraita et al., 2024; Fauziah & Safari, 2025). Therefore, the use of manipulative media, visual representations, and real-world contexts are important strategies in helping students understand mathematical concepts.

2) The application of Piaget's principles of assimilation and accommodation in mathematics learning

The synthesis of the articles shows that mathematics learning that facilitates the assimilation process is carried out by connecting mathematical problems with students' relevant experiences in everyday life. This indicates that the processes of assimilation and accommodation are important cognitive mechanisms in mathematics learning (Fauziah & Safari, 2025). Assimilation occurs when students integrate new information into their existing knowledge structure. Suppose students calculate the volume of a block using milk cartons. This process incorporates the concept of volume into their everyday experience of container capacity.

Conversely, accommodation occurs when students adjust their cognitive structures to understand new concepts that do not fully correspond to their prior knowledge. In the context of mathematical problem solving, these two processes enable students to develop problem-solving strategies gradually through exploration of concepts, discussion, and reflection on the solution process (Jannah et al., 2020; Fahma & Purwaningrum, 2021; Nurul Maiyah dkk., 2023; Mcleod, 2024). The integration of these two processes will significantly improve students' ability to understand problems, plan strategies, and review solutions.

3) Learning strategies that support the development of mathematical problem-solving abilities

Most studies indicate that learning approaches consistent with Piaget's theory and emphasising the importance of active and exploratory learning strategies support the development of students' mathematical problem-solving abilities. Innovative learning approaches such as Problem-Based Learning (PBL) and the use of manipulative mathematical tools have been proven to increase student engagement in the learning process (Pehkonen et al., 2023; Herold-Blasius, 2024). In this case, students not only follow procedures, but they can also explain the reasons for their strategic choices and

communicate solutions logically in accordance with their cognitive development level. This approach provides students with the opportunity to develop problem-solving strategies independently, while helping them understand the relationship between mathematical concepts and real-life situations.

4) Implications of applying Piaget's theory to mathematical problem-solving abilities

Research shows that there is a consistent pattern of findings, namely an increase in students' active involvement in learning, the quality of classroom interaction, and the ability to think logically and critically in solving real-life contextual mathematics problems (Putri et al., 2024; Anjoon & Paul, 2024). Learning that is tailored to students' cognitive development stages enables them to build a more meaningful understanding of mathematical concepts. This has an impact not only on cognitive aspects, but also on students' attitudes towards mathematics, such as increased confidence and self-regulated learning. In general, the analysed research shows a consistent pattern of findings that mathematics learning which integrates exploratory activities, concrete experiences, and cognitive reflection can improve the mathematical problem-solving abilities of upper primary school students.

Discussion

The findings in this study indicate that Jean Piaget's theory of cognitive development is not only theoretically relevant but also has strong practical implications for teaching problem solving in mathematics in upper primary schools. This means that this theory provides a strong conceptual foundation for understanding how primary school pupils construct mathematical understanding through learning experiences. The results of the literature synthesis confirm that the characteristics of the concrete operational stage influence how students understand mathematical concepts and solve mathematical problems.

These findings are consistent with previous studies showing that mathematics learning that takes into account students' cognitive development stages can improve the effectiveness of the learning process. When pupils are given the opportunity to explore mathematical concepts through concrete objects, visual representations, and contextual situations, they tend to find it easier to build conceptual understanding and develop problem-solving strategies (Zhou & Brown, 2015; Ozkale & Aprea, 2023; Fauziah & Safari, 2025).

From a theoretical perspective, this study reinforces the relevance of Piaget's theory in modern mathematics education. The synthesis of findings shows that the mechanisms of

assimilation and accommodation not only explain the cognitive development process of students, but also play a role in the formation of mathematical problem-solving strategies. These findings are consistent with previous research conducted by Mcleod, (2024), but also makes a new contribution by placing the processes of assimilation and accommodation as the main cognitive mechanisms that explain why upper primary school pupils can switch from intuitive strategies to more logical and structured strategies.

Pedagogically, the results of this study have important implications for primary school mathematics teachers, especially those teaching upper grades. Teachers need to design innovative learning that not only focuses on mathematical procedures, but also provides opportunities for students to build conceptual understanding through exploratory activities and active, meaningful learning experiences. This supports previous research findings and reinforces the idea that conventional learning that does not take into account students' cognitive development has the potential to hinder mathematical problem-solving skills (Anggraita et al., 2024; Anjoon & Paul, 2024).

The implication of this study is that there is a need to integrate innovative mathematics learning with Piaget's theory, such as Problem-Based Learning (PBL) assisted by Islamic modules and dynamic technology (e.g., GeoGebra). This integration not only reinforces abstract concepts and independent learning but also improves students' mathematical problem-solving abilities, making learning more contextual, in-depth and holistic, as well as aligning with the strengthening of students' affective and spiritual character.

CONCLUSION

Summary

Based on a synthesis of 19 articles, this study shows that Jean Piaget's theory of cognitive development is a relevant conceptual framework in supporting primary school students' mathematical problem-solving abilities. Learning that is tailored to the characteristics of the concrete operational stage enables students to build a more meaningful understanding of mathematical concepts. The main findings of this study indicate that the effectiveness of problem solving is influenced by the suitability of mathematics learning design to the characteristics of the concrete operational stage of upper primary school students. In addition, the processes of assimilation and accommodation serve as cognitive mechanisms that help students gradually develop problem-solving strategies. This study contributes theoretically by synthesising the relationship between Piaget's theory and mathematical problem solving, and

provides pedagogical implications for the development of more contextual and student-centred mathematics learning.

Recommendation

Future research, empirically using experimental designs or mixed methods, could directly test the correlation between students' cognitive development stages and their mathematical problem-solving abilities. Furthermore, subsequent research could design mathematics learning programmes that explicitly integrate Piaget's principles with innovative learning approaches, such as Problem-Based Learning (PBL) integrated with Islamic modules supported by GeoGebra, making learning more contextual, in-depth and holistic, as well as strengthening students' affective and spiritual character.

REFERENCES

Agustyaningrum, N., Pradanti, P., & Yuliana, Y. (2022). Teori perkembangan Piaget dan Vygotsky : Bagaimana implikasinya dalam pembelajaran matematika sekolah dasar? *Jurnal Absis: Jurnal Pendidikan Matematika Dan Matematika*, *5*(1), 568–582. https://doi.org/10.30606/absis.v5i1.1440

Anggraita, R. L., Masruroh, U., Listiyani, L., Widyasari, C., & Ernawati, E. (2024). Implementasi teori perkembangan kognitif Jean Piaget dalam pembelajaran matematika di sekolah dasar. *Jurnal Pengembangan Dan Penelitian Pendidikan*, *06*(3), 67–76.

Anjoon, A., & Paul, P. K. (2024). In search of learning problems of students in context of psychology : An analysis of Vygotsky's social development theory. *SSRJournalof Arts, Humanities and Social Sciences (SSRJAHSS)*, *1*(2), 95–101.

Fahma, M. A., & Purwaningrum, J. P. (2021). Teori Piaget dalam pembelajaran matematika. *MUST: Journal of Mathematics Education, Science and Technology*, *6*(1), 31–42. https://doi.org/10.30651/must.v6i1.6966

Fauziah, R. R., & Safari, Y. (2025). Penerapan belajar matematika pada siswa SD dengan teori perkembangan Jean Piaget. *Karimah Tauhid*, *4*(2), 1222–1230.

Herold-Blasius, R. (2024). The role of strategy keys in enhancing heuristics and self-regulation in mathematical problem-solving : A qualitative , explorative , and type-building study with primary school students. *Investigations in Mathematics Learning*, 1–20. https://doi.org/10.1080/19477503.2024.2430135

Jannah, A., Usriyah, L., & Mu'alimin, M. (2020). Implikasi teori psikologi perkembangan Jean Piaget untuk peserta didik sekolah dasar pada pembelajaran matematika. *AKSELERASI: Jurnal Pendidikan Guru MI*, *1*(2), 156–166.

Kaitera, S., & Harmoinen, S. (2022). Developing mathematical problem-solving skills in primary school by using visual representations on heuristics. *Lumat*, *10*(2), 111–146. https://doi.org/10.31129/LUMAT.10.2.1696

Maiyah, I. N., Pratiwi, Y. N., Oktavia, L., Saputra, D. B., & Utami, R. (2023). Implemantasi Teori Piaget Menggunakan Puzzle Pada Materi Pecahan Kelas V Sekolah Dasar. *Jurnal Pengabdian Indonesia*, *1*(1), 32–37. https://doi.org/10.47134/jpi.v1i1.2088

Mcleod, S. (2024). Piaget's theory and stages of cognitive development. *Simply Psychology*. https://doi.org/10.5281/zenodo.15241970

Midgett, C. W., & Eddins, S. K. (2001). NCTM's Principles and Standards for School Mathematics: Implications for Administrators. *NASSP Bulletin*, *85*(623), 35–42. https://doi.org/10.1177/019263650108562305

Omar, M. S. R., Raiyan, A. S. H., Shanaa, H. A. A., & Aboushi, M. "Mohammad J. (2024). The effectiveness of mathematical modeling in developing problem solving skills and eelf-efficacy in mathematics among sixth grade in Palestine. *Pakistan Journal of Life and Social Sciences*, *22*(2), 7793–7808. https://doi.org/10.57239/PJLSS-2024-22.2.00587

Ozkale, A., & Aprea, C. (2023). Designing mathematical tasks to enhance financial literacy among children in grades 1–8. *International Journal of Mathematical Education in Science and Technology*, *54*(3), 433–450. https://doi.org/10.1080/0020739X.2022.2157342

Pehkonen, E., Naveri, L., & Laine, A. (2023). On teaching problem solving in school mathematics. *CEPS Journal*, *3*(4), 9–23. https://doi.org/10.25656/01

Putri, S. R., Fitriana, L., & Kusmayadi, T. A. (2024). Students ' thinking process in solving Pythagoras problems : Piaget ' s theory in adversity quotient. *Journal of Educational Management and Instruction*, *4*(2), 295–306. https://doi.org/10.22515/jemin.v4i2.9692

Susanti, V. D., Krisdiana, I., & Adamura, F. (2020). Students' mathematical critical thinking reviewed from self-regulated learning. *Journal of Physics: Conference Series*, *1613*(1), 012008. https://doi.org/10.1088/1742-6596/1613/1/012008

Suyanto, S. (2023). Analisis pengaruh tingkat kecemasan dan konsistensi belajar terhadap prestasi belajar matematika siswa kelas X SMA Islam Sinar Cendekia Kota Tangerang. *Journal on Education*, *5*(4), 17823–17834.

Umar Sa'ad, T., Adamu, A., & M. Sadiq, A. (2014). The causes of poor performance in mathematics among public senior secondary school students in Azare Metropolis of Bauchi State, Nigeria. *IOSR Journal of Research & Method in Education (IOSRJRME)*, *4*(6), 32–40. https://doi.org/10.9790/7388-04633240

Zhou, M., & Brown, D. (2015). Educational learning theories: (2nd Edition). In *Education Open Textbooks*. https://oer.galileo.usg.edu/education-textbooks/1