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# Project Based Learning on Promoting Children's Critical Thinking Skills: A Systematic Review

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**Abstract**

This paper explores the impact of project-based learning (PjBL) on the development of children's critical thinking skills through a systematic review. PjBL, as a student-centered instructional approach, promotes active learning and deeper understanding by engaging students in projects that solve real-world problems. Research has shown that PjBL is effective in enhancing students' critical thinking, problem-solving, and cognitive skills, as well as their motivation and engagement. This paper adopts a constructivist-based learning module to systematically review and analyze the relevant literature in terms of five main factors: the PjBL learning environment, cognitive process, learner characteristics, social interaction, and assessment and reflection. The results of the research show that PjBL has significant effectiveness in educational practice, especially in enhancing students' critical thinking. This paper aims to provide guidance for educational practice and to inform future research directions.

**Keywords:** Project-based Learning (PjBL), Critical Thinking, Children Educational Practices, Cognitive Development

## Introduction

Project-based learning (PjBL) is a student-centered instructional approach that promotes active learning and deeper understanding by engaging students in projects that solve real-world problems (Guo et al., 2020). PjBL emphasizes student inquiry, collaboration, and reflection so that students not only gain knowledge, but also develop critical 21st-century skills, including critical thinking, innovation, and team cooperation (Guo et al., 2020; Tamim & Grant, 2013).

Critical thinking is an important cognitive skill that involves analyzing, evaluating, and reasoning to make sound judgments and decisions (Heard et al., 2020). In the fast-changing modern society, critical thinking is crucial for individual and societal adaptability and innovation (Heard et al., 2020). Therefore, educators and researchers are increasingly concerned about how to effectively develop students' critical thinking skills.

Project-based learning (PjBL), as an instructional strategy, is believed to be effective in promoting the development of critical thinking (Sari & Prasetyo, 2021). It stimulates students'

curiosity and inquisitiveness by providing real-world problems and challenges, prompting them to utilize and enhance their critical thinking skills in the problem-solving process (Sari & Prasetyo, 2021). However, while there are many studies that support the positive effects of PjBL on critical thinking, there are also studies that show inconsistent or limited results (Ferrero et al., 2021; Guo et al., 2020).

Given the diversity of existing research findings, the purpose of this systematic review is to explore the impact of project-based learning on the development of children's critical thinking skills by systematically reviewing and analyzing the relevant literature. The specific research question is how project-based learning affects children's critical thinking development. By answering this question, we hope to provide guidance for educational practice and inform future research directions.

The motivation for this study stems from the growing importance of critical thinking in the 21st century, where innovative problem-solving skills have become particularly important in light of rapidly evolving technologies and complex global challenges (Dakhi et al., 2020). Despite the growing body of research on project-based learning (PjBL), there is still a need for a comprehensive review that integrates and evaluates these findings to gain a clear understanding of the impact of PjBL on children's critical thinking. This study identifies gaps in the research by synthesising the most recent studies and provides practical insights for educators to implement effective PjBL strategies.

## Method

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (O'Dea et al., 2021). The purpose of the literature search strategy was to obtain research on the impact of project-based learning (PjBL) on critical thinking in educational settings. The PRISMA guidelines will provide this study with detailed steps and criteria for systematically collecting, screening and analysing relevant literature for research data on the impact of project-based learning (PjBL) on critical thinking in educational settings. The rigorous screening and analysis will ensure that the process of literature search and analysis is highly scientific and reliable, providing a solid foundation for subsequent findings.

## Research Question

The main research question guiding this review is: How project-based learning affects children's critical thinking development in various educational contexts. This question can be examined in the following ways. RQ1: The effect of PjBL on children's analytical skills: to assess whether children are able to analyze information, problems, and situations more effectively after the implementation of PjBL. RQ2: The effect of PjBL on children's reasoning skills: to examine whether children are able to reason and think logically in a more rational manner after the implementation of PjBL. RQ3: The effect of PjBL on children's problem-solving Ability: to research whether PjBL promotes children's ability to find and implement solutions when faced with complex problems.

Piaget's theory of stages of cognitive development divides children's cognitive development into four stages (Babakr et al., 2019). According to Piaget's definition, kindergarten children are in the preoperational stage. Children in this stage begin to develop basic logical thinking and problem-solving skills, but these skills are not yet fully developed (Babakr et al., 2019). Children's analytical, reasoning, and problem-solving skills contribute to an understanding of the impact of PjBL on the cognitive abilities of children at this critical

stage of development (Djavairovna, 2023). Analyzing, evaluating and synthesizing in Bloom's taxonomy of cognitive domains are among the higher-level cognitive abilities (Assaly & Smadi, 2015; Krathwohl, 2002). For children in kindergarten, their cognitive development has not yet fully reached these higher levels, and therefore, research tends to focus more on their developing abilities such as analyzing, reasoning, and problem solving (Babakr et al., 2019). Therefore, based on an understanding of the stages of children's cognitive development and consideration of Bloom's taxonomy of cognitive domains, the selection of these three competencies as the focus of the research enables the study to be more focused on exploring the impact of project-based learning on children's critical thinking development.

**Literature Search Strategy**

In order to systematically review the impact of project-based learning (PjBL) on children's critical thinking development, this study employed a comprehensive literature search strategy. A detailed literature search was conducted in major electronic databases such as Scopus, Web of Science, and ERIC. The search terms were "project-based learning" or "PjBL" as well as "critical thinking" and "child ". In addition, to increase the comprehensiveness of the search, a number of relevant synonyms and variants were considered, such as "project-based learning", "PjBL", "experiential learning" and "hands-on learning", as well as "critical thinking", "reasoning skills", "analytical thinking" and "problem-solving skills".

The search strategy was designed to gather a wide range of literature on the impact of PjBL on children's critical thinking for in-depth analysis and synthesis. To ensure timeliness and relevance of the research, the search was limited to studies published between January 2019 and December 2023 in English. The literature search and screening process is shown in Figure 1 below, with a PRISMA flowchart detailing the various steps of literature screening, including identification, screening, eligibility assessment and the final number of studies included.

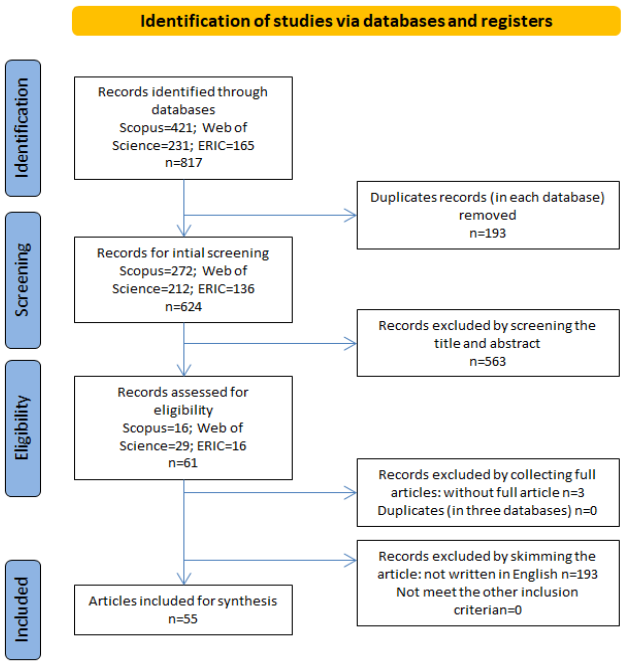


Figure 1. PRISMA flow chart

As shown in Figure 1, a total of 817 articles were retrieved through databases such as Scopus, Web of Science and ERIC during the identification phase. Subsequently, a total of 624 articles were screened after removing duplicate records. In the screening stage, 563 articles were excluded through title and abstract screening. In the eligibility stage, 61 articles were evaluated in detail, and 55 articles finally met the inclusion criteria and were included in the review.

**Eligibility Criterion**

In order to ensure that the studies were systematic and rigorous, a detailed set of inclusion and exclusion criteria were developed to screen for appropriate studies. These criteria helped determine which studies would be included in this systematic review and ensured that only studies of high relevance and quality were included. Inclusion criteria included that studies needed to focus on the effects of PjBL on critical thinking and that the subjects had to be children. In addition, studies needed to provide quantitative or qualitative data on changes in critical thinking skills and were limited to full-text studies published between January 2019 and December 2023 in English.

Table 1
*Inclusion and exclusion criteria*

| Type of Criteria | Standard Description |
|---|---|
| Inclusion Criteria | Research focuses on the impact of PjBL on critical thinking.<br>Research is conducted on children.<br>Research provides quantitative or qualitative data on changes in critical thinking skills.<br>Research is published between January 2019 and December 2023.<br>Full text is available.<br>Article is written in English. |
| Exclusion Criteria | Research does not focus on the impact of PjBL on critical thinking.<br>Research is not conducted on children.<br>Research does not provide quantitative or qualitative data on changes in critical thinking skills.<br>Research is published before January 2019 or after December 2023.<br>Full text is not available.<br>Article is written in a language other than English. |

A detailed description of these inclusion and exclusion criteria is demonstrated in Table 1. These inclusion and exclusion criteria ensured that the selected studies were highly relevant and reliable, providing a solid foundation for this systematic review.Inclusion and exclusion criteria (Table 1), combined with the PRISMA process, resulted in 55 studies selected for inclusion in this systematic review (Figure 1).

**Data Extraction and Data Synthesis**

This research adopted a learning model based on constructivism, which emphasizes that knowledge is constructed in a specific context through active learner exploration and social interaction (Bada & Olusegun, 2015). Adapted to the specific context of PjBL, five main factors were selected from the model to address the above research questions. As shown in Figure 2, these factors include PjBL learning environment, cognitive processes, learner

characteristics, social interaction, and assessment and reflection. These factors are interrelated and explain the intrinsic connection between the fields of PjBL research (Bada & Olusegun, 2015).

This analytical framework was constructed based on the constructivist learning theory proposed by Piaget and Vygotsky (Bada & Olusegun, 2015). The aim is to provide a structured guide for the comprehensive analysis of this paper and to ensure the scientific and practical nature of the findings. Constructivist theory emphasises that knowledge is constructed through the interaction between individuals and their environment. In PjBL, children actively construct and reconstruct knowledge by engaging in real-world problem solving. This theory places particular emphasis on the cognitive development of the individual and is suitable for analysing how children's analytical, reasoning and problem-solving skills are enhanced through social interaction and reflection in project activities.

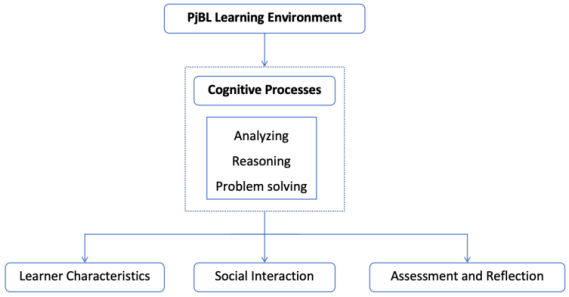


Figure 2. Analytical framework of PjBL and coding scheme

The learning environment describes the real-world problems and situations that PjBL provides for children and how it promotes active inquiry and interaction through program activities (Chen & Yang, 2019). Learner characteristics emphasize children's roles in PjBL (e.g., inquirer, problem solver, and cooperator) and the impact of their prior knowledge, experiences, and interests on the learning process (da Silva & Helnywati, 2021). Cognitive processes cover the three areas of concern of the research question: analytical skills, reasoning skills, and problem-solving skills (da Silva & Helnywati, 2021). This research will explore how PjBL contributes to the development of these abilities.

Specifically, we will connect these cognitive processes with learner characteristics, social interaction, and reflection in the following ways.

Analytical Skills. In PjBL, children enhance their analytical skills by analyzing information and data in project tasks. Learner characteristics, such as curiosity and observational skills, are crucial for the development of analytical skills (da Silva & Helnywati, 2021). Social interaction, such as group discussions and peer evaluations, provides children with opportunities to share and compare different perspectives, thereby enhancing their analytical abilities (Heo et al., 2010). Reflection activities, such as journaling and project reviews, help children reflect on their analytical processes and identify areas for improvement (Funa & Talaue, 2021).

Reasoning Skills. PjBL fosters children's reasoning skills by providing evidence-based reasoning tasks. Learner characteristics, such as a critical thinking disposition and logical thinking abilities, are essential for developing reasoning skills (da Silva & Helnywati, 2021). Collaborative problem-solving and teacher guidance in social interactions help children develop and apply reasoning skills (Heo et al., 2010). Through assessment and reflection, children can understand their reasoning processes and apply more effective reasoning strategies in future projects (Funa & Talaue, 2021).

Problem-Solving Skills. In PjBL, the real-world problems faced by children stimulate their problem-solving abilities. Learner characteristics, such as creativity and adaptability, are crucial for effective problem-solving (da Silva & Helnywati, 2021). Social interaction, such as role-playing and teamwork, provides diverse approaches to solving complex problems (Heo et al., 2010). Assessment and reflection help children evaluate their problem-solving strategies and make improvements in future projects (Funa & Talaue, 2021).

Therefore, the research data in this review was not only collected based on the focus of each included paper, but also extracted from every possible element of the paper to ensure a thorough and comprehensive analysis. Through this approach, we expect to gain a deeper understanding of the impact of PjBL on the development of children's critical thinking skills.

**Results and Discussion**

In this section, it is explained the results of research and at the same time is given the comprehensive discussion. Research found that project-based learning (PjBL) achieved significant results in improving students' critical thinking, problem solving, and cognitive skills. By engaging in PjBL, children were able to analyse problems, formulate hypotheses, find solutions and evaluate them more effectively, an approach that has been shown to have a positive effect on improving children's scientific literacy in science education in particular. In addition, PjBL has significantly increased children's motivation and engagement, enabling them to learn and apply knowledge more deeply in solving real-world problems.

**Year of Publication**

In order to understand the publication trend of research related to project-based learning (PjBL) and critical thinking, this study counted and analysed the number of relevant publications between 2019 and 2023. This trend is visualised through graphs and charts, as shown in Figure 3. According to Figure 3, the trend in the number of publications related to project-based learning and critical thinking from 2019 to 2023. There is an overall increasing trend in the number of publications from 2019 to 2023, with a slight decrease in 2020. This may indicate that interest in project-based learning and critical thinking is increasing over time, while the slight decrease in 2020 may be due to various factors such as the global COVID-19 pandemic that may have affected research and publication activities. The number of publications peaked in 2023, indicating a continued rise in interest in this area of research.

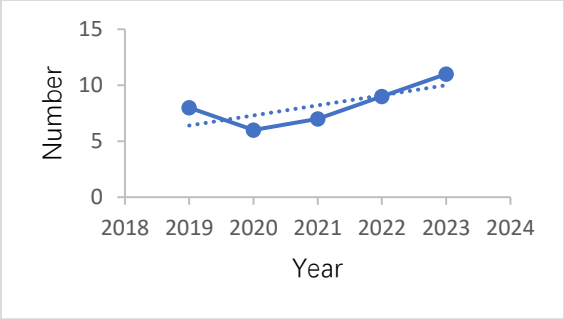


Figure 3. Distribution by publication year

**Participants**

In order to gain a comprehensive understanding of project-based learning (PjBL) in different groups of learners, this section categorises and analyses the participants in the study. The participants were predominantly children and adolescents, and the research covered a range of age groups and subject areas.

The majority of the literature focuses on various studies on improving children's different competences through project-based learning (PjBL). Figure 4 statistically shows the relationship between the different research foci and the amount of literature. The horizontal axis represents the categories of competencies that have been studied, such as critical thinking, problem solving, cognitive skills, scientific literacy, and motivation and engagement. The vertical axis represents the amount of literature that has examined each competency. As shown in Figure 4, the majority of research has focused on improving students' overall critical thinking skills, followed by problem solving skills. There is also a large number of studies that focus to a lesser extent on cognitive skills, scientific literacy, and motivation and engagement. This distribution is indicative of the areas of focus of PjBL research and highlights critical thinking as a key area of concern.

The review study focused on children and adolescents as participants. Figure 5 clearly presents the age distribution of the participants. As shown in Figure 5, the studies covered a wide range of ages, with a particular predominance of kindergarten children. Participants in these studies ranged in age from 3 to 18 years old. In particular, some studies focused on younger children (e.g., 3-6 year olds).

Combined with Figures 4 and 5, it can be seen that this literature explores how PjBL promotes critical thinking skills in this age group of children. The studies cover different subject areas such as maths, science and environmental education. A study designed an approximately four-week STEM enrichment program, Designing Healthy Popsicles, to enhance children's critical thinking, research, design, evaluation, revision, and presentation skills (Bubnick et al., 2016). Another research examined Community Super Investigators Club, an extracurricular program that uses project-based learning to explore how children can enhance an animal's environment (Farmer et al., 2019). Additionally, there have been several studies focusing on a larger age group, 10-18 year old middle school students, that have explored the effects of PjBL on critical thinking in different subject contexts. Research by Muhibbuddin et al found that implementation of the PjBL model can improve students' scientific literacy and critical thinking skills (Muhibbuddin et al., 2020). Although most of the studies focused on students, there were some studies that focused on teachers' roles and perceptions of PjBL. A study by Issa Heba Bani and Khataibeh Abdullah explored how science teachers perceived the effectiveness of PjBL strategies in improving students' critical thinking skills (Issa & Khataibeh, 2021).

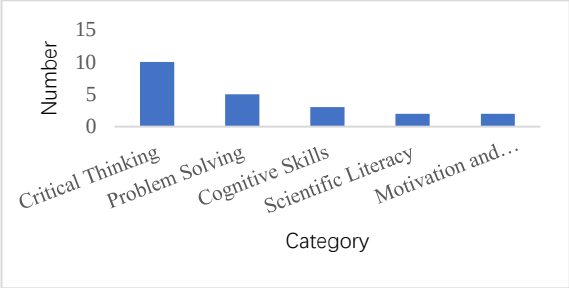


Figure 4. Distribution of research on students

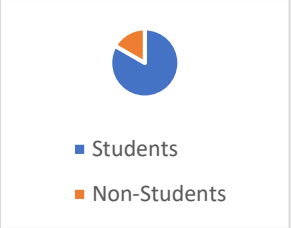


Figure 5. Distribution of research on participants

In addition, this study analyses participants while understanding the geographical areas covered by these studies. The countries and regions covered in most of the studies include North America (e.g., the United States and Canada), Europe (e.g., the United Kingdom), Asia (e.g., China and Japan), and Australia and New Zealand. The different regions reflect the

widespread use of PjBL in different cultures and education systems, and the global applicability of PjBL.

These studies show that PjBL is used in educational practices in different regions of the globe. PjBL is effective in improving children's critical thinking skills even among kindergarten and lower primary school students. By providing children with opportunities to explore real-world problems, PjBL encourages them to think, question, and solve problems, thereby developing their critical thinking skills.

*Technologies*

In order to explore the various techniques used in project based learning (PjBL) studies, this study categorised and analysed the frequency of application of techniques in these literatures. The frequency of application of these techniques is visualised through statistical graphs as shown in Figure 6.Figure 6 shows the frequency of various techniques mentioned in Project Based Learning (PjBL) research. The research techniques can be grouped into seven categories: project-based learning and its variants, STEM education, educational frameworks, educational research, assessment and evaluation, 21st century skills development, and critical and analytical thinking.

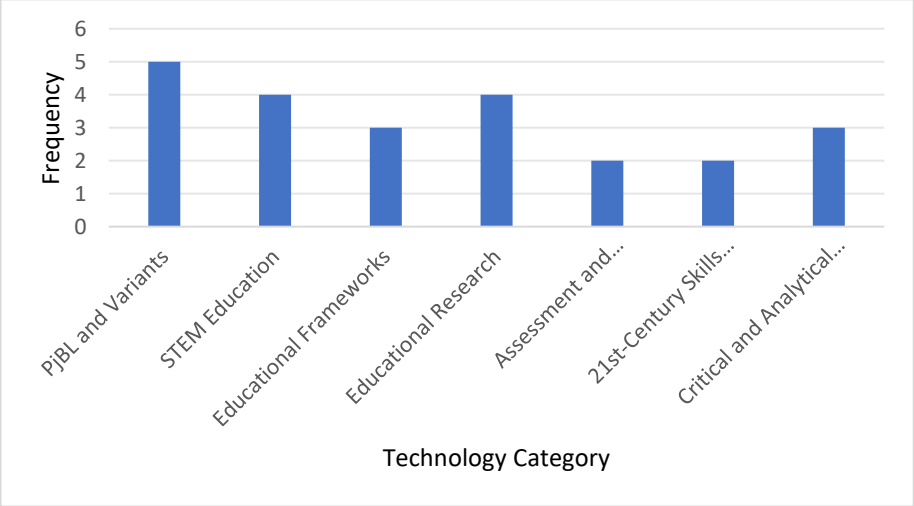


Figure 6. Frequency of application of different techniques in PjBL

Project-based learning and its variants, which emphasizes different forms of project-based learning and their adaptation to improve critical thinking skills.STEM education, which emphasizes research on the integration of science, technology, engineering, and mathematics (STEM) in PjBL to develop analytical and problem-solving skills. Educational frameworks, research that explores various educational frameworks and models (e.g., design thinking and interdisciplinary approaches) that support PjBL. Educational research, literature reviews and meta-analyses investigating the effectiveness of PjBL in educational settings. Assessment and Evaluation, articles researching methods and instuments for assessing the impact of PjBL on critical thinking skills.

In the field of educational research, Project Based Learning (PjBL) and its variants have emerged as an important method for improving students' critical thinking skills. Notably, research by Nur'aini, D.A. et al and Rahim, A.C. et al emphasized the efficacy of PjBL focusing on STEM and formative assessment in improving critical thinking skills (Nur’aini et al., 2022; Rahim et al., 2019). Furthermore, Khoiri, N. et al demonstrated the positive impact of PjBL on students' critical and creative thinking skills in physics learning through traditional games

(Khoiri et al., 2023). Furthermore, Sari, I.K. et al compared problem-based learning (PBL) and project-based learning (PjBL) to reveal their respective effects on students' critical thinking skills (Sari & Prasetyo, 2021).

STEM education has also received much attention for its contribution to 21st century skill development, and systematic reviews by Ilma Arina Zaida et al and Yulianti, S. et al have emphasized the importance of STEM education in this regard (Ilma et al., 2023; Yulianti & Herman, 2023). Yulianti, S. et al have further emphasized the importance of STEM project-based integrated learning for critical thinking in mathematics (Yulianti & Herman, 2023). Ravi, R.V. et al.'s discussion of the importance of STEM education and its pedagogical strategies continues to be a central theme in contemporary research in education (Ravi et al., 2023).

Explorations of educational frameworks and learning models reveal the potential of interdisciplinary frameworks. Interdisciplinary frameworks integrate a variety of tools that promote active learning and critical thinking (Trigos & Pérez-González, 2023). Kemp, S.'s innovative design curriculum, which combines Science, Technology, Engineering, Art, Mathematics (STEAM) with human-centered design, has been recognized for its role in fostering real-world skills such as critical thinking (Kemp, 2023). Role has been recognized. In addition, Chistyakov, A.A. et al.'s research on the characteristics and effects of learning in science and STEAM education provides valuable insights into educational methods (Chistyakov et al., 2023).

Educational research and reviews play an important role in understanding the promise of PjBL and its impact on higher-order thinking. The review by Loyens, S.M.M. et al and the literature review by Nurhidayah, I.J. et al make significant contributions in this area (Loyens et al., 2023; Nurhidayah et al., 2021). Jia, L. et al.'s review of Design Thinking and Project-Based Learning (DT-PjBL) review further enriches the discourse in this area (Jia et al., 2023).

Assessment and evaluation continue to be key components in measuring the effectiveness of educational programs. Lowther, Deborah L. et al.'s investigation of the effectiveness of a curriculum that prepares teachers to engage students in critical thinking (Lowther et al., 2008), and Nur'aini, D.A. et al.'s research on the impact of formative assessment in STEM approaches versus PjBL are are noteworthy contributions (Nur’aini et al., 2022).

The development of 21st century skills has been a focus of Thanyaphongphat et al.'s research analyzed the relationship between 21st century skills and motivation in contextual inquiry-based project-based learning (CI-PjBL) (Thanyaphongphat et al., 2023). Baran, M. et al researched the impact of project-based STEM (PjbL-STEM) applications on the development of 21st century skills (Baran et al., 2021). Baran, M. et al investigated the impact of a project-based STEM (PjbL-STEM) application on the development of 21st century skills, further demonstrating the effectiveness of these approaches (Baran et al., 2021).

Finally, a focus on critical and analytical thinking is emphasized by research such as Maor, R. et al.'s that delved into the relationship between metacognition, creativity, and critical thinking in self-reported instructional performance (Maor et al., 2023). Furthermore, Kamerikar, U. et al improved higher-order skills through project-based learning in engineering education, highlighting the importance of these skills in modern education (Kamerikar et al., 2019).

In conclusion, the exploration of techniques and methods in the context of PjBL allows for a comprehensive understanding of their impact on children's critical thinking skills and addresses research questions related to analytical, reasoning, and problem-solving skills.

*Effects*

The results of this systematic review show that Project-based Learning (PjBL), as an innovative pedagogical approach, has achieved significant results in educational practice, especially in improving children's critical thinking, problem solving and cognitive skills. These effects not only reflect the practical value of PjBL, but are also closely related to the Analytical framework of this study, especially the application of constructivist learning theory. Constructivist theory emphasises the construction of knowledge through interaction with the environment, and it is by engaging children in solving practical problems that PjBL facilitates the process of knowledge construction. During the project, children must analyse information, formulate hypotheses, explore solutions and evaluate the results, activities that continue to deepen their understanding of the problem and their ability to analyse it.

Research has shown that by engaging in PjBL, children are able to analyse problems, formulate hypotheses, find solutions and evaluate them more effectively.The importance of PjBL in improving children's critical thinking and problem solving skills has been highlighted by Cortazar Catalina et al.'s study as well as Muhibbuddin et al.'s study (Cortázar et al., 2021; Muhibbuddin et al., 2020). This coincides with the stages of cognitive development mentioned in Piaget's and Vygotsky's constructivist theories, where children develop more advanced cognitive and problem-solving skills through active exploration and reflection. In addition, social interaction as an important part of the learning process is also reflected in PjBL. Children strengthen their social communication skills while improving their reasoning skills through discussion and collaboration during project cooperation.

In addition, PjBL improves children's cognitive skills. In PjBL activities, children are required to process information, make decisions and apply knowledge, which promotes the development of cognitive skills.Krishnan demonstrated how PjBL improves children's cognitive skills through multimedia and human-computer interaction sessions (Krishnan, 2019). Also, the use of PjBL in science education has shown its positive effects on improving children's scientific literacy, as shown in the study by Muhibbuddin et al (Muhibbuddin et al., 2020).

PjBL not only improves children's academic skills, but also enhances their motivation and engagement in learning. By providing problems and tasks with real-world relevance, PjBL increases the relevance and meaning of learning, thus stimulating children's interest and engagement. Cortazar et al.'s study demonstrated how online PjBL can enhance students' critical thinking and increase their motivation to learn by scaffolding them with socially shared regulation (Cortázar et al., 2021).

Consequently, the educational effects of PjBL are not only in terms of children's skills and competence enhancement, but also in terms of its long-term impact on children's overall cognitive and social interaction skills. These findings fully support the use of constructivist theory as a theoretical basis for PjBL implementation and emphasise the importance of applying theoretical principles to practical teaching and learning activities. In conclusion, PjBL provides a rich and challenging learning environment that is effective in enhancing children's critical thinking, problem solving and cognitive skills, as well as motivation and engagement. Through interdisciplinary projects, collaborative learning, technology integration and student-centred teaching, PjBL has demonstrated its remarkable effectiveness and wide application in educational practice.

## Conclusion

This systematic review explores the impact of project-based learning (PjBL) on the development of children's critical thinking skills. Through a comprehensive analysis of the relevant literature, we found that PjBL has demonstrated significant effects in educational practice, particularly in enhancing students' problem-solving, analytical, and reasoning skills.PjBL stimulates students' curiosity and inquisitiveness by providing them with real-world problems and challenges, prompting them to apply and enhance their critical thinking skills in the process of problem solving.

The results of our research indicate that PjBL is applied to educational practice in a variety of ways, including interdisciplinary projects, cooperative learning, technology integration, and student-centered instruction. These applications provide an integrative learning experience that promotes communication and collaboration among students while enhancing motivation and engagement.

Although this systematic review revealed the effectiveness of project-based learning (PjBL) in promoting the development of children's critical thinking skills, the findings also suggest that different implementation environments, education systems, and cultural contexts may influence the effectiveness of PjBL. Therefore, future research should consider broader geographic and cultural comparisons to explore the adaptability and effectiveness of PjBL in different countries and cultural contexts. Such comparative studies could help to understand how cultural differences affect the design of project-based learning and student learning outcomes. In addition, future research should focus on the long-term effects of PjBL on critical thinking skills of students of different age groups. Although this review covered a range of age groups, there is still a lack of research on the long-term effects of PjBL on the critical thinking development of students in preschool and early secondary school. Long-term follow-up studies could provide deeper insights to help educators and policy makers understand and optimise PjBL strategies. What's more, given the importance of technology in modern education, future research should explore how digital tools and online learning platforms can be integrated with PjBL and how this integration affects student motivation, engagement, and outcomes. It is particularly important to understand how technology can support the effective implementation of PjBL, especially in distance learning environments, which are becoming more common globally.

In conclusion, although project-based learning (PjBL) has been shown to be an effective pedagogical approach, more in-depth studies addressing different aspects of PjBL application are needed to realise its full potential. These studies will improve educational researchers' understanding of PjBL educational strategies and will also provide more concrete and practical guidance for educational practice. Through these efforts, project-based learning can be better designed and implemented in the future, making it more effective and inclusive globally.

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