

THE EFFECTIVENESS OF THE SCIENTIFIC APPROACH ON THE CRITICAL THINKING SKILLS OF 5-6 YEAR OLD CHILDREN-A SYSTEMATIC LITERATURE REVIEW

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ABSTRAK: Kemampuan berpikir kritis merupakan keterampilan esensial yang perlu dikembangkan sejak usia dini guna menghadapi tantangan abad ke-21. Penelitian ini bertujuan untuk mengkaji efektivitas pendekatan saintifik dalam meningkatkan kemampuan berpikir kritis anak usia 5–6 tahun melalui tinjauan pustaka sistematis (systematic literature review). Data dikumpulkan dari sepuluh artikel ilmiah terpilih yang dipublikasikan antara tahun 2020 hingga 2025 dan dianalisis berdasarkan kriteria inklusi dan eksklusi yang ketat. Hasil studi menunjukkan bahwa pendekatan saintifik secara signifikan meningkatkan kemampuan berpikir kritis anak, terutama dalam aspek mengamati, menanya, menalar, memecahkan masalah, dan menyimpulkan. Pendekatan ini efektif diterapkan dalam berbagai konteks pembelajaran, termasuk pembelajaran konvensional maupun yang mengintegrasikan teknologi dan metode inovatif seperti mind mapping, makerspace, dan problem-based learning. Keberhasilan implementasi sangat dipengaruhi oleh kompetensi guru, dukungan lingkungan belajar, serta keterlibatan orang tua. Namun, tantangan seperti keterbatasan pemahaman guru, minimnya sumber daya, dan rendahnya partisipasi orang tua masih menjadi hambatan. Meskipun efektivitas jangka pendeknya telah terbukti, diperlukan penelitian longitudinal untuk menilai dampak jangka panjangnya terhadap perkembangan kognitif anak. Dengan demikian, pendekatan saintifik direkomendasikan sebagai strategi pembelajaran utama dalam pendidikan anak usia dini untuk membangun fondasi berpikir kritis secara optimal.

Kata Kunci: Pendekatan Saintifik; Berpikir Kritis; Anak Usia Dini

ABSTRACT: Critical thinking skills are essential skills that need to be developed from an early age to face the challenges of the 21st century. This study aims to assess the effectiveness of the scientific approach in improving the critical thinking skills of children aged 5-6 years through a systematic literature review. Data were collected from ten selected scientific articles published between 2020 and 2025 and analyzed based on strict inclusion and exclusion criteria. The study results show that the scientific approach significantly improves children's critical thinking skills, especially in the aspects of observing, questioning, reasoning, problem solving and concluding. This approach is effectively applied in various learning contexts, including conventional learning as well as those that integrate technology and innovative methods such as mind mapping, makerspace and problem-based learning. Successful implementation is strongly influenced by teacher competence, learning environment support, and parental involvement. However, challenges such as limited teacher understanding, lack of resources and low parental participation are still obstacles. Although its short-term effectiveness has been proven, longitudinal research is needed to assess its long-term impact on children's cognitive development. Thus, the scientific approach is recommended as the main learning strategy in early childhood education to optimally build the foundation of critical thinking.

Keywords: Scientific Approach; Critical Thinking; Early Childhood

INTRODUCTION

Critical thinking skills are essential cognitive skills that need to be developed from an early age as a foundation in facing the challenges of the 21st century. In children aged 5-6 years, the cognitive development phase is at the preoperational stage, where children begin to be able to do symbolic thinking, ask questions, and show high interest in various

phenomena around them. This ability, if facilitated with the right learning approach, can develop into a more structured critical thinking ability.

One approach that is widely recommended in the early childhood education curriculum is the scientific approach. This approach emphasizes five main steps in learning to observe, question, try, reason, and communicate which are in line with the critical

thinking process. Alucyana and Raihana's study (2023) shows that the scientific approach is able to stimulate children's thinking activities logically and analytically through active exploration in learning activities. This is also supported by the research of Ni Luh Ardia P. R. Cahyani et al. (2024) who found that consistent application of the scientific approach in group B PAUD classes had a positive impact on improving children's critical thinking skills.

However, although the scientific approach has been widely adopted in early childhood learning in Indonesia, its implementation is often not optimal and tends to be procedural without a deep understanding of its purpose in building critical thinking. O'Reilly, Devitt and Hayes (2022), in their international literature review, found that there are still gaps in the literature regarding the explicit integration of critical thinking skills in preschool curriculum and classroom practice. Many educators do not fully understand how the scientific approach can be translated into concrete strategies that promote critical thinking skills in children.

On the other hand, the dynamics of early childhood education today demand learning innovations that are not only fun but also meaningful and shape reflective thinking. With the development of global challenges, children need to be equipped with higher-level thinking skills from an early age, including the ability to analyze information, solve problems, and make simple decisions. Therefore, it is important to evaluate in depth the effectiveness of the scientific approach on the critical thinking skills of children aged 5-6 years empirically and contextually.

This systematic literature review was guided by three research questions:

- a. What are the main findings of previous studies on the effectiveness of the scientific approach in developing critical thinking skills in children aged 5-6 years?
- b. What are the outcomes, challenges and enablers of implementing this approach based on the empirical findings?

- c. To what extent is the effectiveness of the scientific approach on the critical thinking skills of children aged 5-6 years?

This study aims to identify, analyze, and synthesize scientific literature that discusses the effectiveness of the scientific approach to the critical thinking skills of children aged 5-6 years.

METODE

This study conducted a systematic literature review (SLR) to identify, analyze, and synthesize scientific literature that discusses the effectiveness of the scientific approach on the critical thinking skills of children aged 5-6 years. The purpose of this study is to deepen our understanding of the main findings of previous studies on the effectiveness of the scientific approach in developing critical thinking skills of children aged 5-6 years, what are the results, challenges, and supporting factors of implementing this approach based on existing empirical findings and the extent of the effectiveness of the scientific approach on the critical thinking skills of children aged 5-6 years.

This study seeks to highlight the effectiveness of the synoptic approach in improving critical thinking skills of children aged 5-6 years.

The methodology used in this study adheres to a transparent framework for SLR, as outlined by McFadden et al. (2012).

Search Strategy

The main data sources to be explored are Scopus, ScienceDirect. In addition, a search for National articles was also carried out with the SINTA database. The literature search strategy was conducted using a systematic technique to identify relevant studies on the synoptic approach and critical thinking skills of 5-6 year old children. The methodology in this study used a transparent and rigorous framework for SLR, as outlined by McFadden et al. (in Robiah Al Adawiyah, et al: 2024). Search using the keywords "*critical AND thinking AND scientific AND approach AND preschool*". This search process spanned three weeks, from March 20 to April 30, 2025.

Inclusion and Exclusion Criteria

Strict inclusion and exclusion criteria were applied to ensure the quality and relevance of the selected studies. These criteria included:

Table 1. Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Publication Date	Articles published in the 2020-2025 timeframe.	Articles published before 2020
Language	Articles are published in English to ensure relevance and accessibility.	Articles published in languages other than English.
Study type	Original peer-reviewed research articles, including quantitative, qualitative, and mixed-methods studies that address scientific learning approaches and critical thinking skills.	Book, dissertation, thesis, or conference proceedings. Unpublished opinion article, editorial, review, or thesis
Methodological Quality	Articles with clear research design, data analysis, and adequate sample size.	Articles with insufficient methodological rigor, such as unclear research design, limited data analysis, or insufficient sample size.
Population	Studies that focus on the Early Childhood Education (5-6 years) level	Research involving children beyond 5-6 years of age
Research focus	Studies relevant to the scientific approach in early childhood learning (PAUD) in improving critical thinking skills, especially in the 5-6 year age group.	Studies that use other approaches in improving critical thinking skills.
Geographic Scope	International studies relevant	National studies relevant to

Data Extraction and Synthesis

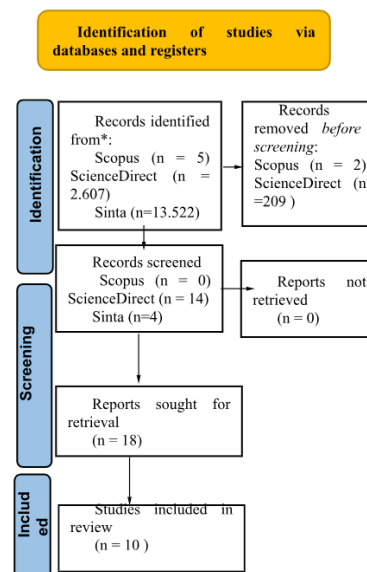
After the identification stage, ten studies that met the inclusion criteria were selected for review in this study.

During the initial identification stage, duplicate articles were removed, and the remaining articles were screened based on their titles and abstracts. This screening process revealed several studies that examined the scientific approach in improving children's critical thinking skills. Next, the full texts of the selected studies were evaluated to determine their eligibility. This assessment resulted in a final selection that focused on the scientific approach in improving children's critical thinking skills. In this narrative

analysis, special attention was paid to themes that emerged from the selected studies, offering deeper insight into some of the approaches that can be used in improving children's critical thinking skills. By carefully searching, selecting and analyzing the relevant literature, we will build a strong foundation to discuss the practical and theoretical implications of these findings within the field of early childhood education.

The article selection process will be made using PRISMA Flowchart. And for reference management using Mendeley:

Figure 1. PRISMA flow diagram of study selection (Source: <https://prisma-statement.org/>)



Picture1. Identification of Studies

RESULT AND DISCUSSION

This section discusses the main findings obtained from the 10 articles that have been reviewed based on the systematic review process. The results are presented in several sections, each of which answers the previously formulated research questions.

Table 2. Table of Literature Matrix

Reference s & Titles	Study Objectives & Study Design	Target Group & Age	Strategie s and Subcategories	Results
Alucyana & Raihana, S.(2023). <i>I mplementa tion of a scientific approach</i>	Research the effectivene ss of the scientific approach in improving	Childre n aged 5-6 years in kinder garten.	Scientific approach with experime ntation, Observat ion, and	Improved children's critical thinking skills through scientific

<i>to improve critical thinking in children aged 5-6 years.</i>	the critical thinking skills of children aged 5-6 years. Experimental design		group discussion.	methods.
Fatimah, N. (2021). <i>The effectiveness of the scientific approach in improving the critical thinking skills of group B kindergarten children.</i>	Measuring the effectiveness of the scientific approach in improving critical thinking skills in kindergarten children. Quasi-experimental design	Group B kindergarten children (5-6 years old).	Experiment with observation, structured conversation, and reflection methods.	Children's critical thinking skills improved significantly after the application of the scientific approach.
Nugroho, A., et al. (2020). <i>Scientific approach in early childhood education to foster critical thinking skills.</i>	Assessing the impact of the scientific approach on the development of early childhood critical thinking skills. Qualitative research design.	Children aged 5-6 years in kindergarten.	Scientific approach through experimentation, observation, and reflection.	The scientific approach is effective in stimulating children's curiosity and critical thinking.
Sari, T., & Widodo, H. (2022). <i>Teacher strategies in developing children's critical thinking skills through a scientific approach.</i>	Analyzing the strategies used by teachers in developing critical thinking skills through the scientific approach. Case study design.	Teachers and children aged 5-6 years.	Experimentation, observation, structured discussion.	The use of scientific strategies by teachers showed an increase in children's critical thinking skills.
Cahyani, N. L. A. P. R., et al. (2024). <i>Implementation of a scientific approach to the critical thinking ability of group K1 B children at Taman Rama Jimbaran Kindergarten.</i>	Analyzing the application of the scientific approach to early childhood critical thinking skills. Experimental design.	Group K1 B children (5-6 years old).	Scientific approach with experiments and direct observation.	The scientific approach is effective in developing children's critical thinking skills.

O'Reilly, C., Devitt, A., & Hayes, N. (2022). <i>Critical thinking in the preschool classroom: A systematic literature review.</i>	Presents a systematic literature review on the application of critical thinking in preschool classrooms. Design of the literature review.	Preschool children (4-5 years old).	A literature review on the application of critical thinking in the preschool classroom.	The use of a scientific-based approach has the potential to improve critical thinking in preschool.
Zevender, P. S., et al. (2024). <i>Learning model development of Moodle-based problem-based learning to improve critical thinking ability.</i>	Developing a learning model based on Moodle and problem-based learning to improve critical thinking skills. Development research design.	Early childhood to elementary school age	Moodle-based and problem-based learning models.	The use of this model is effective in improving children's critical thinking skills.
Özkan Kunduracı, H. K., et al. (2024). <i>Measuring parental behaviors that support higher Order thinking skills in children: A scale development study.</i>	Developing a scale to measure parental behaviors that support higher Order thinking skills in children. Scale research design.	Early childhood to elementary school age.	Scale measuring parental behavior in supporting higher order thinking.	Parental behavior support the development of children's higher-order thinking skills.
Polat, Ö., & Aydın, E. (2020). <i>The effect of mind mapping on critical thinking skills in young children's critical thinking skills.</i>	Assessing the effect of mind mapping on critical thinking skills in young children. Experimental design.	Children aged 5-6 years.	Mind mapping technique in learning activities.	Mind mapping improves early childhood critical thinking skills.
Yang, W., et al. (2025). <i>Making a makerspace in early childhood education: Effects on children's STEM thinking skills and emotional development.</i>	Analyzing the impact of makerspace creation on children's STEM thinking skills and emotional development. Experimental design.	Early childhood (4-6 years).	Making a makerspace to support STEM and critical thinking skills.	Makerspaces enhance children's STEM thinking skills and emotional development.

Research question 1: what are the main findings of previous studies on the effectiveness of the scientific approach in developing critical thinking skills in children aged 5-6 years?

Based on a systematic review of 10 articles, it was found that the scientific approach proved to be effective in developing the critical thinking skills of children aged 5-6 years. Most of the studies (Alucyana & Raihana, 2023; Fatimah, 2021; Nugroho et al., 2020; Cahyani et al., 2024) showed that the consistent application of scientific measures such as observantion, questioning, reasoning, trying, and communicating can improve early childhood critical thinking skills. This approach also provides cognitive stimulation through exploration and experimentation activities, which encourage children to structure simple arguments, evaluating information, and finding solutions (Nugroho et al., 2020; Sari & Widodo, 2022).

The success of the application of the scientific approach largely depends on the role of the teacher. Teachers who design learning systematically and apply guided discussions and reflections are able to optimize the development of children's critical thinking (Sari & Widodo, 2022). In addition, this approach has proven to be flexible and remains effective when combined with a variety of contexts learning, such as digital media (Zevender et al., 2024), mind mapping (Polat & Aydın, 2020), or makerspace (Yang et al., 2025). Home environment factors also affect the effectiveness of scientific learning. Parental support that encourages high-level thinking skills can synergize with learning strategies in schools to develop children's abilities holistically (Özkan Kunduracı et al., 2024).

These findings are in line with global trends showing that scientific approaches are increasingly being adopted in preschool education in various countries (O'reilly et al., 2022), although adjustments to the local context are still needed.

Overall, the scientific approach contributes significantly to the development of early childhood critical thinking skills, especially when applied systematically by teachers, supported by the family environment, and combined with creative methods. This

approach is an important foundation in forming a reflective, analytical and solutive child from an early age.

Research question 2: what are the outcomes, challenges and enablers of implementing this approach based on the empirical findings?

Results:

Based on a review of ten articles analyzed, the application of the scientific approach in early childhood is proven to provide various positive results, especially in the development of critical thinking skills. The main results found show that this approach significantly improves children's critical thinking skills, including the ability to observe, analyze, solve problems and draw logical conclusions. This is reflected in the findings of several studies, such as those reported by Alucyana and Raihana (2023), Fatimah (2021), and Nugroho et al. (2020), which consistently showed significant improvements in these aspects after the application of the scientific approach.

The scientific approach is also known to increase children's curiosity and learning independence. Children become more active in asking questions, exploring the surrounding environment, and trying to find solutions to the problems they face independently. This finding is supported by the research of Cahyani et al. (2024) and Polat & Aydın (2020), which emphasize the important role of this approach in fostering an explorative and autonomous learning spirit from an early age.

In certain learning contexts such as makerspaces, the scientific approach can even strengthen skills in STEM (Science, Technology, Engineering, and Mathematics) while supporting children's social-emotional development. A study by Yang et al. (2025) shows that science-based activities designed with a scientific approach can provide space for children to develop cognitive abilities as well as interaction skills and manage emotions.

Overall, the evidence from these studies confirms that the scientific approach is an effective learning strategy in developing various aspects of critical thinking and other abilities that are important for early childhood development.

Challenges in Implementing the Scientific Approach:

Although the scientific approach has proven effective in developing critical thinking skills in early childhood, its implementation in the field is inseparable from various challenges. One of the main challenges is teacher readiness and pedagogical skills that still vary. Not all teachers have a deep understanding or adequate skills to design and manage the learning process based on the scientific approach effectively. This was expressed by Sari and Widodo (2022), who highlighted the importance of training and mentoring for educators so that they are able to integrate this approach into daily learning practices.

In addition, limited time and resources are also a significant obstacle. The scientific learning process in early childhood requires more time to allow children to explore, ask questions and experiment. This approach also requires appropriate tools and media to support children's explorative activities. Fatimah (2021) notes that limited infrastructure and limited time allocation often hinder the optimization of the learning process with this approach.

Another important challenge is the need for differentiation of learning strategies. Early childhood children have different developmental speeds and learning styles, so the application of the scientific approach must be tailored to the characteristics and needs of individual children. Nugroho et al. (2020) emphasize that without appropriate adjustments, the effectiveness of this approach may be reduced as not all children respond to learning strategies in the same way.

Another challenge is that the lack of parental involvement is also an obstacle in implementing a holistic scientific approach. Support from the family environment is still not optimal, even though the consistency of developing children's critical thinking skills is strongly influenced by the active role of parents at home. Özkan Kunduracı et al. (2024) showed that parents' involvement in accompanying children's exploration and discussion process is very important to strengthen the learning outcomes carried out at school.

Thus, although the scientific approach has great potential in developing critical thinking skills in early childhood, its success is highly dependent on teacher readiness, resource support, adaptive learning strategies, and the active role of parents in the child's education process.

Factor Supporting the Success of the Scientific Approach

The application of the scientific approach in early childhood education has proven effective in improving the critical thinking skills of children aged 5-6 years. The successful implementation of this approach is inseparable from a number of supporting factors that are interrelated and reinforce each other. One of the main factors is teacher competence and creativity. Teachers who have the ability to design learning activities that are interesting, meaningful, and in accordance with the scientific approach are an important key in creating an effective and enjoyable learning process for children. Sari and Widodo (2022) emphasize that skilled and creative teachers can facilitate learning experiences that foster curiosity and higher order thinking skills in children.

In addition to the role of the teacher, an open learning environment that supports exploration is also a significant supporting factor. The presence of varied learning media, exploration spaces such as makerspaces, and experimental tools are important means of supporting scientific activities that involve the process of observation, experimentation, and discovery by children. Studies by Yang et al. (2025) and Zevender et al. (2024) show that a supportive physical environment greatly influences children's active participation and engagement in the science-based learning process.

The effectiveness of the scientific approach also increases when combined with technology and innovative learning methods. Integration with models such as problem-based learning, use of visual aids such as mind mapping, and utilization of digital platforms such as Moodle can enrich children's learning experience. Research by Polat and Aydın (2020) and Zevender et al. (2024) highlighted that this integrated approach can create more

interactive, reflective and contextualized learning.

Another factor that contributes to the success of the scientific approach is collaboration between schools and parents. When parents actively support the development of higher order thinking skills at home, the learning outcomes at school become more optimal and sustainable. Özkan Kunduracı et al. (2024) underline the importance of the family's role in strengthening the consistency of the development of children's critical thinking skills.

However, the success of this approach is also highly dependent on the ability to overcome various challenges, such as limited resources and teacher readiness. Therefore, continuous training for educators, provision of adequate facilities, and strong synergy between the school and family environment are essential to ensure the effectiveness and sustainability of the implementation of the scientific approach in early childhood education.

Research question 3: To what extent is the scientific approach effective on the critical thinking skills of children aged 5-6 years?

The results showed that the scientific approach contributes significantly to the improvement of cognitive aspects of critical thinking in early childhood. Few studies explicitly apply this approach (Alucyana & Rihana, 2023; Fatimah, 2021; Cahyani et al., 2024) found that children experienced significant development in a number of critical thinking indicators. These indicators include the ability to ask questions, analyze information from observations, draw simple conclusions, as well as solve problems in the context of learning activities. This improvement in skills is generally significantly measurable in a variety of research designs, both quasi-experimental and controlled experiments.

In addition, the effectiveness of the scientific approach shows strong consistency across contexts. This approach has been shown to be effective in a wide variety of study designs, from experiments to case studies to systematic reviews. This consistency is also seen in various geographical contexts such as

Indonesia, Europe, and East Asia. In addition, this approach is successfully applied through various learning models, including problem-based learning, direct experimental activities, to the use of technology such as Moodle. These findings reinforce the argument that the scientific approach is adaptive and flexible, so it can be widely applied in early childhood education.

The study conducted by Fatimah (2021) specifically compared the effectiveness of the scientific approach to conventional learning methods. The results showed that the group of children who took part in learning with a scientific approach had a higher critical thinking score compared to the control group using conventional methods. The advantages of this approach appear mainly in the ability of simple analysis and decision-making carried out by the child.

Nevertheless, it should be noted that most of the studies examined showed more short-term effects of applying the scientific approach. Meanwhile, empirical evidence supporting its effectiveness in the long term is limited and has not been fully tested.

CONCLUSION

This study shows that the scientific approach has significant effectiveness in developing critical thinking skills in early childhood, especially children aged 5-6 years. This finding is based on a systematic review of ten scientific articles that represent various learning contexts and research methods. The scientific approach is proven to be able to encourage the development of key indicators in critical thinking, such as children's ability to observe, ask questions, reason, solve problems, and draw simple conclusions. The improvement of these abilities is consistently seen in various study designs, both experimental and quasi-experimental.

The effectiveness of this approach is not limited to one particular type of learning, but is also seen in a variety of contexts, ranging from conventional learning to learning that integrates technology and innovation, such as problem-based learning, mind mapping, and the use of exploration spaces such as makerspaces. This shows the flexibility and adaptability of the scientific approach to various early childhood learning situations.

However, the success of the scientific approach is determined by several important factors. Teacher competence in designing and facilitating exploration-based learning is a key aspect that influences its effectiveness. Creative and skillful teachers can create a learning environment that fosters children's curiosity and reflective thinking. In addition, the quality of the learning environment and parents' involvement at home are also significant supporting factors in strengthening children's learning outcomes.

Although proven effective, the implementation of the scientific approach in the field still faces a number of challenges. Limited teachers' understanding and pedagogical skills, lack of adequate facilities and time, and low parental involvement are obstacles that need to be overcome. Therefore, the success of this approach depends not only on the application of the method itself, but also on the readiness and overall support of the education system, including the provision of resources and training for educators.

The effectiveness of the scientific approach is more evident in the short term, but to determine its sustainable impact on children's cognitive development, further research with a longitudinal design is needed. Nonetheless, this approach can be recommended as a key strategy in early childhood education, given its potential to form the foundation of critical thinking from an early age. To optimize the results, it is necessary to increase the capacity of teachers, provide a supportive learning environment, and strong synergy between schools and families.

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