Neuroscience-Based Learning in Early Childhood Education to Shape Character

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ABSTRACT

Neuroscience-based learning is an educational approach that emphasizes the integration of how the brain, emotions, and children's learning experiences interact. This research aims to analyze the role of neuroscience-based learning in early childhood education as an effort to develop character holistically. Through a literature review of various theories and previous research findings, this study highlights how positive stimulation, a safe learning environment, and healthy social interaction contribute to brain development and the formation of children's character values. The results of the study show that learning aligned with the brain's working mechanisms can foster empathy, independence, responsibility, and self-control. In addition, this approach encourages teachers to act as facilitators who understand differences in children's learning styles and create brain-friendly learning environments. Although its implementation in Indonesia still faces challenges, particularly regarding educators' neuroscience literacy, this approach has the potential to become an essential foundation for early childhood character education in the future. Thus, neuroscience-based learning not only develops intellectual intelligence but also nurtures strong, empathetic, and humanistic character from an early age.

INTRODUCTION

Early childhood education (PAUD) is a fundamental phase in the human development process. During this period, children experience rapid growth in cognitive, affective, social, and motor aspects that form the foundation for future personality development (Komari & Aslan, 2025). Therefore, education at an early age should focus not only on academic skills but also on character building. Through character education, children can learn to internalize moral values such as honesty, responsibility, empathy, and discipline. Unfortunately, many PAUD institutions still prioritize academic aspects such as reading, writing, and arithmetic (calistung) rather than instilling character values (Lickona, 2015; Sousa, 2017). This indicates a gap between the ideal goals of early childhood education and practical implementation in the field, which often fails to align with children's overall developmental needs.

One of the main challenges in Indonesia's education system is the low effectiveness of character formation in early childhood. Many teachers still use conventional, teacher-centered methods that rely on instruction and memorization (Ahmad et al., 2022). Such approaches fail to account for individual differences, how children process information, and the emotional factors that significantly influence learning. As a result, learning tends to be mechanical and lacks meaningful emotional and social experience. In fact, research shows that children's character develops through positive interactions, empathetic experiences, and learning environments that

stimulate curiosity and positive emotions. Teachers' limited understanding of how children's brains function often hinders character formation because the process is not aligned with the natural mechanisms of brain development and behavior.

Neuroscience, the scientific study of the nervous system and brain function, offers valuable insights into how learning processes and behaviors are formed (Sari et al., 2024). By understanding neuroscience, educators can learn how the brain responds to stimuli, how memory is formed, and how emotions influence children's thinking abilities (Azizah et al., 2023). Neuroscience principles affirm that effective learning must consider emotional engagement, attention, and sensory experiences. In the context of early childhood education, applying neuroscience helps teachers design learning activities suited to children's stages of brain development (Firdaus et al., 2025). Thus, learning not only emphasizes cognitive growth but also encompasses affective and social dimensions that play major roles in character formation. Neuroscience provides a scientific foundation for teachers to understand that every child's behavior has biological and psychological roots that can be positively guided through appropriate educational approaches.

The relationship between neuroscience and character formation lies in the brain's role in managing emotions, morality, and social behavior. Brain regions such as the prefrontal cortex play key roles in moral decision-making, self-control, and empathy (Alamsyah, 2025). When children experience learning that stimulates these brain areas, they become more capable of understanding moral concepts and demonstrating prosocial behavior. Neuroscience-based learning emphasizes the importance of maintaining a positive emotional climate in the classroom because stressful or tense conditions hinder the brain's optimal functioning in processing information (Wijaya, 2018). Therefore, integrating neuroscience principles into early childhood education fosters a learning environment that is enjoyable, nurturing, and respectful of each child's uniqueness. When the brain is calm and happy, children absorb character values more naturally through daily interactions (Armini, 2024; Awhinarto & Suyadi, 2020; Hadisi, 2015).

In neuroscience-based learning, teachers are not merely content deliverers but facilitators who understand how children's brains learn. They act as "architects of learning experiences," capable of designing stimulating activities that support brain and character development (Rustiyana, 2025). This requires teachers to possess neuroscience literacy, enabling them to adapt teaching methods to children's neurological and emotional needs. For instance, play, music, movement, and art-based approaches are known to stimulate both hemispheres of the brain in a balanced way. Additionally, teachers must recognize that each child's learning rhythm differs according to their brain structure and maturity. By adopting a neuroscience-based approach, teachers can create a more natural and less stressful learning experience that fosters confidence—an essential foundation for positive character building.

The integration of neuroscience into early childhood learning represents a strategic effort to enhance the quality of character education in Indonesia. A deeper understanding of brain function can help teachers and parents create environments conducive to children's moral, emotional, and social growth (Nisa & Bisri, 2025). Moreover, this approach aligns with 21st-century education policies emphasizing holistic learning—the development of the child's full potential, including intellect, emotion, and behavior. Applying neuroscience principles does not require advanced technology but rather teacher awareness to adapt interactions, classroom atmospheres, and teaching methods to align with how the brain works. Thus, neuroscience is not only a scientific

field but also a practical foundation that reshapes how educators perceive, understand, and guide children to learn and grow into individuals of strong character.

Based on this description, this study focuses on analyzing the role of neuroscience-based learning in early childhood education as an effort to shape children's character holistically. This research is conceptual in nature, reviewing theories and prior studies to explore the relationship between neuroscience principles and character development in early childhood. Its main objective is to identify neuroscience principles relevant to the learning process and examine how their application can strengthen character values such as empathy, independence, and responsibility. Through this literature-based approach, the study aims to provide a more comprehensive understanding of how learning aligned with brain function supports character formation from an early age. Furthermore, the results are expected to serve as a reference for educators and policymakers in developing scientific, humanistic, and development-oriented learning strategies that support children's brain and character growth.

METHOD

This study employs a literature review approach, systematically analyzing various theories and findings from previous research relevant to neuroscience-based learning in early childhood education. The analysis focuses on how positive stimulation, the creation of a safe and conducive learning environment, and the quality of healthy social interaction support children's brain development while fostering character values. To conduct this analysis systematically, a content analysis method is applied, beginning with the collection of literature from credible sources such as scientific journals, books, and academic articles published within the last ten years using relevant keywords.

The gathered literature is then selected based on criteria of topical relevance, source credibility, recency, and applicability to the Indonesian educational context (Zim, 2025). Data extracted from the selected literature are organized into key themes related to neuroscience principles, the relationship between brain development and character formation, learning strategies, and implementation challenges. Thematic analysis is used to examine the data, involving processes of coding, categorization, thematic synthesis, and critical interpretation of findings.

This methodological approach allows for a comprehensive exploration of the conceptual relationships between brain mechanisms, learning experiences, and the internalization of character values in early childhood. To ensure validity and reliability, source triangulation is conducted by comparing findings across different studies, and an implicit peer-review process is incorporated through conceptual discussions with experts in early childhood education and neuroscience. Through this structured approach, the study aims to provide an in-depth and systematic synthesis of how neuroscience-based learning can be integrated into early childhood character education and its implications for policy and practice.

RESULT AND DISCUSSION

1. Neuroscience Facts That Support Early Childhood Character Building

Neuroscience explains that early childhood is a golden age during which the brain develops rapidly and exhibits high plasticity. During this period, learning experiences have a significant impact on the formation of neural pathways that influence children's cognitive, social, and

emotional development. Research shows that loving interactions, multisensory stimulation, and a safe, enjoyable learning environment can enhance the activity of brain regions such as the prefrontal cortex—the area responsible for self-control, decision-making, and empathy (Berkowitz & Bier, 2018; Immordino-Yang, 2016; Tokuhama-Espinosa, 2019; Zull, 2017).

In the context of character education, neuroscience provides a scientific foundation showing that behavior and moral values are not merely the result of social habituation but are also influenced by children's biological and emotional development. By understanding this relationship, educators can design learning that not only emphasizes cognitive growth but also supports emotional regulation, empathy development, and positive interpersonal relationships as the foundation for strong character formation from an early age.

2. Application of Neuroscience-Based Learning in Early Childhood Education

The application of neuroscience principles in early childhood education emphasizes the importance of creating a learning experience that is in harmony with how the brain works. An effective learning process occurs when children feel safe, accepted, and valued. Therefore, teachers need to build a positive classroom atmosphere and avoid teaching methods that cause stress, because the stress hormone (cortisol) has been shown to inhibit brain development. Neuroscience-based learning also emphasizes the importance of play, art, and sensory exploration as a means of developing the right and left brain functions in a balanced manner. Through activities such as role-playing, music, storytelling, and group collaboration, children not only learn academic concepts but also cultivate social-emotional skills such as cooperation, empathy, and a sense of responsibility. In this framework, teachers play the role of facilitators who understand the stages of children's brain development and are able to adjust learning strategies to their developmental needs.

3. Implementation Challenges and Recommendations in Indonesia

Although the concept of neuroscience-based learning offers a holistic and scientific approach, its application in Indonesia still faces several challenges. One of the main obstacles is the low neuroscience literacy among early childhood educators, so these principles have not been widely integrated into daily learning practices. In addition, limited facilities, teacher training, and curriculum that still focus on academic aspects are obstacles in implementing this approach optimally. Therefore, ongoing training is needed for educators to understand the basics of neuroscience, as well as the development of a curriculum that supports learning that stimulates the brain in a positive way. The government and educational institutions also need to strengthen collaboration with neuroscientists and developmental psychologists so that early childhood education policies are more based on scientific research. With these steps, neuroscience-based learning has the potential to become a strategic foundation in building a generation that is intellectually, emotionally, and morally intelligent.

CONCLUSION

This study confirms that neuroscience-based learning plays an important role in holistically shaping early childhood character. The principles of neuroscience show that a child's brain development is directly influenced by the learning experiences, social interactions, and emotional

states they experience. Therefore, brain-friendly learning processes form the foundation for developing character values such as empathy, responsibility, honesty, and independence. Learning that aligns with how the brain works not only stimulates cognitive aspects but also fosters emotional and social connectedness in children.

Neuroscience thus provides a scientific basis reinforcing the view that character education should begin at an early age through approaches that balance the affective, cognitive, and physiological aspects of a child's development. Furthermore, neuroscience-based learning requires teachers to understand that every child has unique potentials and learning styles. Teachers are not merely content deliverers but facilitators capable of creating safe, enjoyable, and meaningful learning environments. This approach encourages early childhood education to become a process that not only nurtures the mind but also shapes the heart and behavior.

By understanding how the brain works and its relationship with emotions, teachers can instill character values through natural and enjoyable learning experiences. Based on this study's findings, it is recommended that educators, early childhood education institutions, and policymakers take a more proactive role in integrating neuroscience principles into curricula and teaching practices. Teachers should receive continuous training on brain function and developmentally appropriate learning strategies. The government and higher education institutions are also encouraged to expand research and promote awareness of neuroscience's importance in early childhood character formation, ensuring that educational policies are increasingly grounded in scientific evidence. Moreover, parents should be actively involved since the family environment serves as the first and most influential context for character formation. Through collaboration among teachers, parents, and policymakers, neuroscience-based learning can become an educational strategy that not only fosters academic intelligence but also develops strong, empathetic, and socially conscious character from an early age.

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