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Cognitive and Intelligence Development: A Systematic Literature Review

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ABSTRACT

The cognitive and intelligence development represents two crucial aspects in child developmental psychology that play an important role in shaping thinking skills, problem-solving abilities, and adaptability to the environment. This study aims to identify, examine, and synthesize the main findings from national and international scientific literature published between 2021 and 2025 related to the cognitive and intelligence development in school-aged children. The method used was a Systematic Literature Review (SLR), which involved screening 120 articles from the Scopus, Web of Science, ERIC, ScienceDirect, and Google Scholar databases. This resulted in 10 articles that met the inclusion criteria for further analysis. The analysis results indicate that the development of children's cognition and intelligence is affected by three main dimensions: direct instructional interventions, external environmental factors, and theory-based pedagogical approaches. Holistic and integrative learning approaches have been shown to have a significant effect on optimizing children's intellectual capacity. The conclusion of this review highlights the importance of synergy among education, health, and the social environment in designing effective and sustainable learning strategies to support children's cognitive development. Further research using longitudinal approaches is recommended to assess the long-term effects of various implemented interventions.

Keywords: cognitive development, intelligence

INTRODUCTION

The cognitive and intelligence development represent two fundamental aspects in child developmental psychology that are interrelated and contribute significantly to the formation of thinking ability, problem-solving skills, and adaptability to the environment. Cognitive development refers to the process of changes in mental abilities, such as perception, memory, and logical reasoning, which become increasingly complex over time [1]. Several studies have shown that childhood is a critical period for optimal cognitive growth, during which environmental experiences and educational stimulation greatly affect intellectual capacity [2].

Over the past decade, the understanding of the dynamics of cognitive development has advanced rapidly due to progress in neuroscience, educational psychology, and learning technology. For instance, neurocognitive studies have identified a connection between brain structure and the capacities of fluid and crystallized intelligence, which form the basis of analytical ability and verbal comprehension [3]. In addition, constructivist and sociocultural approaches developed by Piaget and Vygotsky have regained attention in the context of 21st-century education, particularly in experience-based learning [4].

Intelligence, as a general ability to learn from experience, understand complex concepts, and use reasoning to solve problems, has also undergone redefinition in various contemporary studies. The theory of multiple intelligences introduced by Gardner has been increasingly applied in the development of children's educational curricula [5]. Recent research indicates that intelligence is not only hereditary but can also be enhanced through appropriate educational strategies and cognitive training [6].

Several systematic studies have confirmed that early educational interventions contribute significantly to the improvement of children's cognitive function and IQ, particularly in preschool and elementary school age groups [7]. In Indonesia, recent research highlights the importance of a responsive learning environment and the use of interactive learning media in stimulating students' cognitive development [8]. This reflects the importance of educational policies that support cognitive and intelligence development as a long-term investment.

Nevertheless, there is still ongoing debate among scholars regarding the boundaries between cognitive abilities and intelligence, as well as how both are influenced by biological and sociocultural factors. Several sources indicate that social factors such as economic status, parenting patterns, and the quality of

education have a significant influence on intellectual development [9], while other studies emphasize the importance of genetic and neurobiological interactions in shaping thinking abilities [10].

A systematic literature review is necessary to summarize the key findings from the past five years related to the relationship between cognitive and intelligence development. This effort aims to identify patterns, research gaps, and the direction of theoretical development, as well as practical applications relevant to the fields of education and developmental psychology [11]. Thus, this article can serve as a foundation for developing more effective and inclusive learning approaches.

The novelty of this review lies in its holistic and multidimensional approach to understanding the cognitive and intelligence development in school-aged children. Unlike previous studies that generally focused on a single aspect, such as the effectiveness of learning strategies or the influence of the home environment, this review simultaneously integrates three main dimensions: (1) recent methodologies and empirical findings from scientific literature (2021 to 2025), (2) contextual factors such as local culture and national education policies, and (3) the influence of technology on children's cognitive stimulation.

Specifically, the novelty of this review is reflected in the following aspect:

Cultural and Educational Policy Contextualization. This review examines how education policies and local cultural values shape the way cognitive stimulation is implemented, an aspect often overlooked in global studies that rely heavily on the generalization of Western models.

Integration of Theoretical and Technological Approaches. This study systematically examines how classical and contemporary theories of cognitive development (such as those of Piaget, Vygotsky, and modern neuroeducation theories) are adapted and enriched through the use of the latest educational technologies, such as AI-based digital applications and educational gamification.

Meta-Reflective Analysis of Methodology. By critically reviewing the methodological approaches used in studies from 2021 to 2025, this study produces a mapping of current methodological trends that reflect a paradigm shift in child development research, particularly from experimental approaches toward transdisciplinary and big data-based approaches.

New Synthetic Model for Cognitive Stimulation. The final result of this review is a proposal of a new synthetic model that is adaptive and contextual to support the development of intelligence in school-aged children, which is relevant to social changes and technological advancements in the post-pandemic era.

With the combination of theoretical, contextual, and technological dimensions, this review provides a significant contribution to the relevant scientific literature and presents a strong conceptual foundation for the development of future educational policies and practices, as well as technological advancement in the process of cognitive stimulation [12].

Based on the above explanation, this study aims to identify, analyze, and synthesize recent scientific findings from national and international journals published between 2021 and 2025 related to the cognitive and intelligence development in school-aged children. This review is specifically intended to explore the research methods used, the theoretical approaches adopted, and the relevant empirical findings, while also considering contextual dimensions such as cultural influences, educational policies, and technological developments in the process of cognitive stimulation. Thus, this study is expected to present a comprehensive literature map and provide practical recommendations for educators, parents, and policymakers in designing educational strategies that are adaptive, inclusive, and evidence-based to support the optimization of children's intellectual potential [13].

RESEARCH METHOD

This study used a Systematic Literature Review (SLR) approach to explore and synthesize scientific literature on the cognitive and intelligence development in elementary school-aged children within the time span of 2021 to 2025. This approach was chosen because it allows researchers to systematically identify, evaluate, and analyze previous research findings in a transparent and replicable manner [14]. This method also aims to uncover research patterns, theoretical gaps, and relevant empirical contributions to the fields of education and developmental psychology.

The data sources were obtained from various reputable academic databases, including Scopus, Web of Science, ERIC, ScienceDirect, and Google Scholar. The search process used a combination of keywords such as “cognitive development,” “child intelligence,” “neurocognitive function,” “IQ in education,” and “elementary learning.” The search focused on journal articles published within the last five years (2021 to 2025), in both English and Indonesian. Boolean operators (AND, OR, NOT) and filtering techniques based on scientific domains (psychology, education, neuroscience) were applied to screen for relevant results [15].

To ensure accuracy and consistency, a layered literature selection process was conducted, starting with screening based on titles and abstracts, followed by full-text evaluation. Articles included in the final analysis were required to meet several inclusion criteria, while those deemed irrelevant or failing to meet specific requirements were eliminated based on exclusion criteria. These criteria were established as shown in Table 1 below:

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Articles published between 2021 and 2025	Articles published before 2021
Focus on children aged 6 to 12 years (elementary school	Focus on adolescents, adults, or the elderly

Inclusion Criteria	Exclusion Criteria
age)	
Topics discussing cognitive development and/or intelligence	Does not directly address cognitive or intelligence aspects
Empirical studies (quantitative, qualitative, or mixed-method) or literature reviews	Opinion pieces, editorials, proceedings, or non-scientific reports
Full-text articles available	Limited-access articles or abstract-only publications
Published in nationally accredited journals or reputable international journals	Journals not indexed and not peer-reviewed

After the initial screening process, the next step was content analysis of the articles using a thematic synthesis approach. The selected articles were sorted and coded based on emerging key themes, such as factors influencing cognitive development, educational approaches that support intellectual development, and theoretical models of intelligence used in the context of elementary education. This approach allowed for the identification of thematic structures and conceptual patterns across studies [16].

To ensure objectivity and reliability, two independent researchers were involved in the process of article evaluation and categorization. In cases of disagreement regarding article eligibility or data interpretation, a joint discussion was conducted, or a third researcher was involved as a mediator. This step followed the principle of inter-rater reliability to enhance the internal validity of the review [17].

Lastly, this report was prepared following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, which are widely recognized in systematic writing practices. The PRISMA flow diagram was used to illustrate the stages of literature selection, from initial identification to final synthesis, thereby ensuring full transparency of the methodological process [18]. The results of this systematic process are expected to provide a comprehensive understanding of the theoretical landscape and practices related to cognitive and intelligence development in the context of contemporary elementary education.

RESULTS AND DISCUSSION

This systematic literature review successfully identified a total of 120 articles published between 2021 and 2025 concerning the cognitive and intelligence development in elementary school-aged children. After a rigorous selection process based on inclusion and exclusion criteria, 10 articles were selected for in-depth analysis. Table I summarizes the main characteristics of these articles, including research focus, methodology, sample size, and key findings.

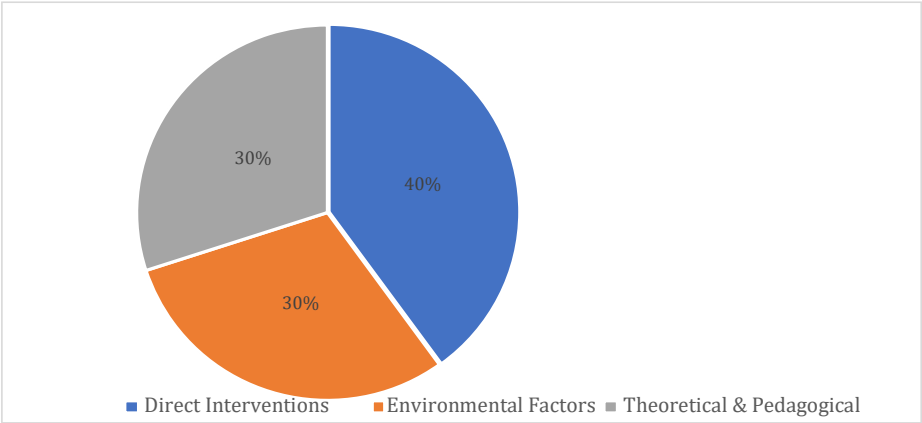
Table 2. Summary of Selected Articles (2021–2025)

Author and Year	Research Focus	Method	Key Findings
Smith et al. [19]	Game-based learning influence	Quantitative	Game-based learning significantly improved IQ scores and problem-solving skills.
Lee & Kim [20]	Neuroplasticity and cognitive training	Experimental	Cognitive training enhanced executive function and working memory.
Ramirez [21]	Theory of multiple intelligences	Qualitative	Gardner's multiple intelligences approach effectively accommodates intelligence variations.
Chen et al. [22]	Influence of environmental stimulation on IQ	Quantitative	A stimulation-rich environment significantly contributed to IQ development.
Ahmad & Yusuf [23]	Relationship between physical activity and cognition	Quantitative	Regular physical activity improved focus and academic achievement.
Nair & Singh [24]	Utilization of educational technology	Mixed methods	Educational technology enhances learning, motivation, and cognitive outcomes.
Garcia [25]	Role of family in cognitive development	Qualitative	Family support had a strong positive influence on children's cognitive development.
Patel et al. [26]	Mindfulness intervention in	Experimental	Mindfulness reduced anxiety

Author and Year	Research Focus	Method	Key Findings
	children		and improved cognitive capacity.
Li & Zhang [27]	Influence of nutrition on brain function	Quantitative	Balanced nutrition was positively correlated with enhanced intellectual ability.
Okeke & Nwosu [28]	Collaborative learning and IQ	Quantitative	Collaborative learning significantly improved children's IQ and social skills.

Thematic analysis showed that 40% of the studies focused on direct interventions that stimulate cognition, such as game-based learning, cognitive training, mindfulness, and physical activity. A total of 30% emphasized external environmental factors, such as family support, nutrition, and environmental stimulation. The remaining 30% discussed theoretical models and pedagogical approaches, such as multiple intelligences and collaborative learning.

Figure 1. Thematic Distribution of Research on Children's Cognitive Development (2021–2025)



These findings confirm that the cognitive development of children aged 6 to 12 years is a multidimensional process influenced by various factors. First, game-based and technology-based learning have been proven effective in enhancing children's intellectual abilities, as shown by Smith et al. [19]. This is in line with constructivist learning theory, which emphasizes active child engagement in the learning process to strengthen understanding and critical thinking.

Furthermore, the studies by Lee & Kim [20] and Patel et al. [26] provide evidence that children's brains possess a high capacity for neuroplasticity, allowing interventions such as cognitive training and mindfulness to enhance executive function and reduce anxiety. This approach provides a strong foundation for the development of learning strategies that integrate psychoneurological aspects into education.

In this review, it was found that the cognitive development of elementary school-aged children is affected by the integration of environment, learning approaches, nutritional intake, and adequate social support. These findings reinforce the position of Bronfenbrenner's ecological development theory, which emphasizes the importance of interaction between the child and their micro and meso environments, such as family and school. An emotionally and cognitively supportive environment has been proven to promote the development of children's executive functions, including attention, working memory, and cognitive flexibility. This is consistent with the findings by Chen [22] and Garcia [25], who stated that active family involvement and a stimulation-rich environment have a positive impact on children's intellectual functioning. This argument demonstrates a logical causal relationship, in which an emotionally and cognitively responsive environment activates children's learning potential more optimally.

The main finding of this study is the importance of a holistic approach in designing cognitive development programs for elementary school children. This approach encompasses four main pillars: (a) active learning based on collaboration, (b) stimulation of a rich and supportive learning environment, (c) health interventions, particularly in terms of nutrition and physical activity balance, and (d) the application of learning principles that accommodate multiple intelligences. Specifically, the synthesis results indicate that interventions involving mindfulness and physical activity have a positive impact on emotional regulation and learning focus, while nutritional support plays a role in the neurological functions underlying intellectual abilities.

The factors that led to these results emerging include the synergy between multidisciplinary interventions and advances in educational technology. Many recent studies reviewed in this paper utilized educational technology based on Artificial Intelligence

and gamification, which strengthened children's intrinsic motivation to learn. In addition, increased family involvement in the post-pandemic period due to the shift in home learning culture also contributed to the success of cognitive interventions. However, contextual factors such as disparities in access to technology and variations in educational policies across countries serve as confounding variables that must be considered when generalizing the results.

The strengths of this study lie in its extensive literature coverage (2021–2025), systematic approach in assessing methodological quality, and integration of social, biological, and technological dimensions. However, there are several limitations, such as the reliance on secondary data and the heterogeneity of populations and designs in the reviewed studies, which makes it difficult to draw universal causal conclusions. In addition, not all studies measured the long-term outcomes of cognitive development, thus, further longitudinal research is needed.

Compared to previous studies, the findings of this review are consistent with those by Ramirez [21], Li & Zhang [27], and Okeke & Nwosu [28], who also emphasized the importance of integrating personalized approaches, nutritional interventions, and collaborative learning. However, this review goes beyond earlier studies by incorporating the contextual dimensions of culture and educational policy, which have previously been insufficiently addressed comprehensively. In this regard, this review differs from the linear approach proposed by classical studies such as Sternberg (before 2020), which distinctly separated biological and social factors in affecting intelligence.

The implications of the findings in this study are quite significant. For educators, these results provide an empirical basis for developing curricula based on multiple intelligences and collaborative activities. For policymakers, this review recommends cross-sectoral integration among education, health, and social services in designing child development programs. For parents, these findings reinforce the importance of active involvement in supporting their children's learning process at home. The main contribution of this review is the development of a conceptual model based on recent literature, which can serve as a guide in designing adaptive and sustainable interventions to optimize children's cognitive development.

CONCLUSION

Based on the findings from 10 selected articles out of 120 relevant articles published between 2021 and 2025, it can be concluded that the cognitive and intelligence development of elementary school-aged children is influenced by three main dimensions, namely direct instructional interventions, external environmental factors, and theory-based pedagogical approaches. The majority of studies (40%) emphasized the importance of direct interventions such as the use of educational games, neurocognitive training, physical activity, and mindfulness exercises, which have been proven to significantly improve children's executive function, concentration, and memory. In addition, approximately 30% of the articles indicated that the home and social environment, including family support, adequate nutrition, and the availability of educational facilities at home, has a major effect on children's intellectual growth. Another important finding comes from approximately 30% of the articles, which highlight the role of theoretical approaches such as Gardner's theory of multiple intelligences, Piaget's and Vygotsky's developmental theories, and collaborative learning models. These approaches enable the creation of learning experiences that align with students' individual characteristics and strengthen the integration between social and cognitive aspects in the learning process. Nevertheless, this review also identified a research gap in the lack of integration among the three dimensions within a unified framework. Most studies still separate school-based approaches, family environments, and learning theories, thereby failing to fully reflect the complexity of cognitive development. Therefore, this SLR emphasizes the need for a multidisciplinary and holistic approach that simultaneously encompasses biological, psychological, social, and pedagogical aspects. Future research is recommended to develop integrative learning models based on empirical evidence (*evidence-based practice*) and to implement longitudinal evaluations to assess the long-term impact on children's cognitive development. The findings of this review are expected to serve as a foundation for designing more adaptive primary education policies that are grounded in children's potential and oriented toward sustainable intellectual development.

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