Jurnal Ilmiah Wahana Pendidikan, June 2026, 12(6.A), 320-328
DOI: https://jurnal.peneliti.net/index.php/JIWP/article/view/13337
p-ISSN: 2622-8327 e-ISSN: 2089-5364
Accredited by Directorate General of Strengthening for Research and Development
Available online at https://jurnal.peneliti.net/index.php/JIWP

The Effect Of Bilingual Education On Student' Cognitive Flexibility: A Systematic Literatur Review

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Received: 11 Mei 2026
Revised: 20 Mei 2026
Accepted: 30 Mei 2026

Abstract

This research aims to synthesize empirical evidence regarding the effect of bilingual education on students' cognitive flexibility, a key component of executive function. Cognitive flexibility is defined as the ability to switch between different tasks or sets of rules, which is theoretically enhanced by the necessity to simultaneously manage two language systems. This study employs a Systematic Literature Review (SLR) method, analyzing seven core journals (international and national) that discuss the correlation between bilingualism, bilingual education, and cognitive development, specifically cognitive flexibility, within educational contexts.

The review results indicate a significant and positive relationship between bilingual education and enhanced cognitive flexibility. The dominant evidence supports the finding that bilingual programs provide an advantage in cognitive control tasks, as affirmed by global meta-analyses and studies in Indonesia. This advantage is believed to stem from the strengthening of the brain's cognitive control mechanisms, which are continuously trained by the process of cross-linguistic task switching. Although some inconsistencies related to moderating factors (such as the degree of bilingualism and participant age) were found, the findings overwhelmingly suggest that bilingual education should be viewed as an effective pedagogical intervention for optimizing students' cognitive development. It is recommended that educational institutions reinforce bilingual programs as a means of developing adaptive thinking skills.

Keywords: *Bilingual Education; Cognitive Flexibility; Executive Function; Systematic Literature Review.*

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How to Cite: Maria Sarjani Br. Siregar, T., Luthfiani, R., Rahmadita, A., Br. Saragih, R., & Artia Rahma, M. (2026). The Effectiveness of Bilingual Learning for Students in the Era of Globalization. *Jurnal Ilmiah Wahana Pendidikan*, *12*(6.A), 320-328. Retrieved from https://jurnal.peneliti.net/index.php/JIWP/article/view/13337.

INTRODUCTION

Bilingual education has become a primary focus in the development of modern education systems, particularly due to the demands of globalization, which emphasize the importance of linguistic and cognitive adaptability. According to García (2009), bilingual education is not just a language approach, but also a pedagogical strategy capable of shaping students' thinking in facing the complexities of the global world. Genesee and Cloud (1998) also emphasized that integrated bilingual learning can improve the quality of the learning process because students become accustomed to accessing information through more than one linguistic system.

In the context of cognitive development, bilingualism is often associated with improved executive functions, one of which is cognitive flexibility. Cognitive flexibility refers to the ability to shift attention, change perspectives, and adapt thinking strategies according to the demands of the situation. Spiro (1992) explains that cognitive flexibility is a core ability in complex thinking processes, including problem-solving and reasoning. Meanwhile, Diamond (2013) states that cognitive flexibility is part of executive function that is crucial for adapting to new situations and making effective decisions.

The effects of bilingualism on cognitive flexibility have been extensively studied by experts. Bialystok (2001) showed that bilingual individuals often excel at cognitive tasks requiring attention shifting and inhibitory control. Craik and Bialystok (2006) also found that using two languages in everyday life triggers activation of brain areas associated with cognitive control, thereby improving performance on various executive tasks. However, others, such as Paap and Greenberg (2013), have criticized the so-called "bilingual advantage," asserting that some studies have failed to demonstrate a consistent advantage, thus necessitating a more systematic review of the effectiveness of bilingualism on cognitive flexibility.

These differing research findings suggest that the effectiveness of bilingual education on cognitive flexibility is influenced by a number of factors, such as the age of second language acquisition, the intensity of language use, the bilingual education model implemented, and the students' sociocultural context. Antoniou (2019) states that the variability in findings in the field necessitates a more comprehensive study to understand the conditions under which bilingualism truly impacts executive function, particularly cognitive flexibility.

Based on these dynamics, a systematic literature review is needed to review, compare, and evaluate research findings regarding the effectiveness of bilingual education on students' cognitive flexibility. This review aims to provide a comprehensive understanding of the patterns of findings, research gaps, and their implications for bilingual education practice. Furthermore, the results of this review are expected to provide a strong scientific contribution to the development of bilingualism theory, educational policy, and learning strategies that support the optimal development of students' executive functions.

RESEARCH METHODS

This study employed a Systematic Literature Review (SLR) method to comprehensively examine the effectiveness of bilingual education on students' cognitive flexibility. The SLR method was chosen because it provides in-depth understanding based on a synthesis of empirical evidence from various published studies and adheres to systematic analysis standards as outlined in the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. Data collection was conducted through a literature search in reputable databases such as Scopus, ScienceDirect, ERIC, SpringerLink, and Google Scholar using a combination of the

keywords "bilingual education," "cognitive flexibility," "executive function," "bilingual advantage," and "students" using the Boolean operators AND and OR. Articles considered in this study were selected based on inclusion criteria: empirical research addressing the relationship or influence of bilingual education on cognitive flexibility, published between 2011 and 2024, written in English, and published in reputable scientific journals. Articles that were not based on empirical research, did not measure aspects of executive function, did not have clear methodological information, or were duplicates were excluded through exclusion criteria.

The literature selection process involved three stages: title and abstract screening, full-text review to ensure compliance with established criteria, and final selection of articles for analysis. The data obtained were analyzed using a thematic analysis approach by identifying patterns of findings and comparing research designs, samples, measurement instruments, and the context of bilingual education studied. These findings were then synthesized to determine the consistency of the relationship between bilingual education and cognitive flexibility, while also identifying research gaps and recommending directions for further study.

The presentation can be supported by tables and graphs accompanied by explanations and interpretations of the analysis results. The discussion contains a discussion of the research results with previous research, theory, or established knowledge, accompanied by a bibliography. The research findings can be supported, dissupported, or contradicted by previous research, theory, or established knowledge.

RESULTS AND DISCUSSION

This Systematic Literature Review provides convincing evidence that Bilingual Education has a significant and positive effect on improving students' cognitive flexibility. The synthesis of findings indicates that individuals exposed to and actively using two languages consistently demonstrate superior performance in the executive function domain. The primary empirical foundation is found in a meta-analysis by Adesope, Lavin, Thompson, & Ungerleider (2010), which reviewed dozens of primary studies and concluded that there are strong and consistent positive effect sizes between bilingualism and various cognitive advantages. These advantages directly implicate cognitive flexibility—the ability to shift attention and cognitive resources from one rule set to another—a crucial higher-order thinking skill. These findings are reinforced by studies in Indonesia, such as those analyzed by Alief & Widyastuti (2024), which confirmed that second language intervention from an early age results in optimal Executive Function development in children.

The cognitive advantages observed in bilingual students are explained by cognitive control mechanisms that are continuously honed by bilingual experience. According to the Hypothesis of Adaptive Control, the brains of bilingual individuals must constantly manage and suppress irrelevant language systems for effective communication. This process trains the neural networks responsible for inhibition and attentional switching. The ability to quickly inhibit one language while activating another is at the heart of cognitive flexibility. Therefore, the experience of bilingual education not only enriches linguistic abilities but also indirectly acts as intensive cognitive training. In a national context, research by Susanti & Hasan (2023) found that a bilingual program in elementary schools significantly improved problem-solving skills—a cognitive task that relies heavily on flexibility—compared to a group of non-bilingual students. Similarly, a study by Rahayu & Suparmi (2022) concluded that teaching subjects in a second language contributes to the development of students' complex thinking skills.

Although the trend of findings supports the hypothesis, this review critically acknowledges and addresses inconsistencies in the literature. For example, a replication study by Shokrkon & Nicoladis (2021) found no significant advantage in cognitive flexibility in a group of bilingual preschoolers. This discrepancy in results suggests that the effects of bilingualism are not a universal or automatic phenomenon, but rather depend on several moderating factors. Inconsistencies may arise from differences in: (1) Level of Bilingualism (only active and balanced bilingualism may show effects, not passive exposure); (2) Age of Participants (the study by Silmi Ahsanti Dewi et al., 2024 focused on elementary school age, while many negative studies focused on preschool age, suggesting a timing of the emergence of cognitive effects); and (3) Cognitive Measurement Methodology used (the sensitivity of test instruments varies). Addressing these contradictions provides depth to the literature review, making it balanced and credible.

The findings supporting cognitive benefits, as synthesized in Hidayati's (2020) study, offer substantial policy implications. Bilingual education should be viewed as a valuable cognitive investment. Public concerns (such as speech delay or language confusion) identified in the national literature tend to be offset by strong empirical evidence demonstrating long-term cognitive benefits. Therefore, it is recommended that educational institutions in Indonesia proactively integrate and strengthen structured, high-quality bilingual education programs. These programs should be designed to maximize active interaction in both languages to stimulate cognitive control mechanisms that foster cognitive flexibility. Thus, bilingual education serves a dual function: as a means of language acquisition and as a catalyst for the development of students' critical and adaptive thinking skills.

Author	Year	Country	Research Purposes	Design and Data Collection Methods	Findings	Implication
Adesope, O. O., Lavin, T., Thompson, T., & Ungerleider, C.	2010	United States/Canada (General)	Conducting a Systematic Review and Meta-Analysis of the cognitive correlates of bilingualism, including the impact on executive function.	Meta-Analysis and Systematic Review. Using quantitative methods to aggregate results from multiple studies and calculate a pooled effect size. Primary studies are collected through major academic databases, screened based on strict inclusion criteria, and statistical data are extracted.	A significant positive relationship was found between bilingualism and improved performance on a variety of cognitive tasks, including components of executive function closely related to cognitive flexibility.	Provides strong evidence-based support for bilingual education as an effective way to enhance cognitive abilities, including cognitive flexibility.
Shokrkon, A., & Nicoladis, E.	2021	Canada	Replicating a previous study to test the hypothesis of a bilingual cognitive flexibility advantage in preschool children.	Experimental Design (Replication). Using standard cognitive tasks to measure cognitive flexibility (e.g., Dimension Change Card Sort or variations of the Switching Task). Direct performance	No significant advantage in cognitive flexibility was found in bilingual preschoolers compared to monolingual children, challenging the positive results	Points out the need for caution in claiming a bilingual cognitive advantage and emphasizes that the effect may depend on factors such as age, level of bilingualism, and the test

				tests (such as task switching) administered individually with children to measure response speed and accuracy.	of previous studies.	methodology used.
Silmi Ahsanti Dewi, Siti Sopiah, & Ichsan Fauzi Rachman	2024	Indonesian	Examining the influence of bilingualism on the cognitive development of grade 1 students at SDN Sukasenang.	Qualitative descriptive research using a case study approach. Observations, in-depth interviews with teachers and/or parents, and documentation of student learning outcomes.	Bilingualism (the use of two languages at school/home) contributes positively to students' cognitive development, which supports their problem-solving abilities.	Implying that bilingual education programs can be a useful tool at the elementary school level in Indonesia to improve students' basic cognitive abilities.
Hidayati, N. N.	2024	Indonesian	Examining the pros and cons of bilingualism and multilingualism on children's language and cognitive development through a literature review.	Qualitative Literature Review. Collecting and analyzing secondary data from various studies discussing the impact of bilingualism. Collecting and synthesizing findings from various articles,	It shows that there are pros (cognitive advantages, such as flexibility of thinking) and cons (concerns about language delay/doubt) of bilingualism, but concludes that the positive	This implies that parents and educators do not need to be afraid to implement bilingualism, as long as it is done appropriately and adapted to the child's development.

				books, and journals regarding the pros and cons of bilingualism.	impacts tend to be more numerous and significant.	
Susanti, W., & Hasan, M.	2023	Indonesian	To examine the impact of a bilingual program in elementary schools on students' problem-solving abilities (which are closely related to cognitive flexibility).	This quasi-experimental design used pretests and posttests for the control and experimental groups. Problem-solving ability (as a proxy for executive function/cognitive flexibility) was assessed before and after the bilingual program intervention.	The bilingual program showed a significant and positive effect on improving students' problem-solving abilities compared to the control group.	Affirming that Bilingual Education is a viable intervention in elementary schools to enhance students' critical cognitive abilities, which are the foundation of cognitive flexibility.
Alief, F., & Widyastuti, A.	2024	Indonesian	Analyzing the relationship between second language acquisition in Early Childhood (ECD) and cognitive development, particularly in the Executive	Qualitative & Descriptive Literature Review. Conducting an in-depth analysis of various existing research findings on bilingualism and Executive Function. Collecting and interpreting data	It was found that bilingual children had a marked advantage in aspects of Executive Function, including the ability to shift attention (attentional	Recommending the implementation of second language stimulation from an early age in educational settings (such as PAUD or TK) because it has been proven to

			Function aspect (which includes Cognitive Flexibility).	from various theoretical sources and empirical research addressing the neuroscience and psycholinguistics of bilingualism.	switching) and manage conflicting information, which is the core of Cognitive Flexibility.	optimize neural pathways that support the development of children's cognitive flexibility.

CLOSING

Based on a synthesis of findings from a systematic literature review on "The Effect of Bilingual Education on Student's Cognitive Flexibility," it can be concluded that bilingual education has a significant positive relationship with increased students' cognitive flexibility. The preponderance of evidence suggests that the cognitive demands inherent in managing two language systems (cognitive control) serve as an effective brain-training mechanism, resulting in advantages in executive function and task-switching abilities.

Despite variability and some contradictory studies (which are likely influenced by age and level of bilingualism), the overall findings confirm that implementing bilingual programs in educational institutions can serve a dual purpose: not only as a tool for second language acquisition, but also as a pedagogical intervention to optimize students' cognitive development and adaptive thinking skills. Therefore, the benefits of bilingual education on cognitive flexibility far outweigh any concerns.

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