

Development Guidelines for Executive Function (EF) Skills in Early Childhood: Needs Assessment in Nonthaburi Kindergartens

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Abstract

Executive function skills are crucial for children in the 21st century, serving as indicators of their readiness for learning. Children with well-developed executive function skills can effectively accomplish various tasks, solve problems using diverse strategies, and collaborate with others happily. This research aims to: 1. Identify the necessity for fostering executive function skills among early childhood students in Nonthaburi Province. 2. Analyze the causes underlying the necessity to promote executive function skills in early childhood students. 3. Propose strategies to enhance executive function skills in early childhood students. The research consists of two phases. Phase 1 involves identifying the necessity for developing executive function skills among early childhood students, with a sample group comprising 12 volunteer kindergarten teachers randomly selected from 12 classrooms and 328 early childhood students aged 5 to 5 years 11 months (162 boys and 166 girls). The research instrument used is the MU.EF-101 assessment. Data analysis involves calculating the mean and standard deviation of T-scores for working memory, inhibitory control, and shift/cognitive flexibility. Phase 2 analyzes the causes of necessity and proposes strategies to promote executive function skills in early childhood students. The data sources for this phase are 12 teachers, and the research instruments include fishbone diagram recording forms and group discussion recording forms. Findings suggest that parental involvement is crucial in training children to perform tasks independently and in teaching children patience. Additionally, teachers should analyze children's behaviors to plan appropriate learning activities based on their context. Teachers must encourage children to think and make decisions independently, encourage when mistakes occur, and ensure the availability of suitable tools and toys that promote the development of executive function skills in early childhood students, which teachers or parents can conveniently utilize.

Keywords: executive function, early childhood, cognitive development, parent-teacher collaboration, educational interventions

1. Introduction of the Study

1.1 Significance and Problems of the Research Study

Developing children and youth into quality individuals is fundamental to societal progress and aligns with the broader national economic and social development plan. The overarching goal is to equip them with the necessary skills and competencies to thrive in the dynamic landscape of the 21st century (Howard et al., 2019). By nurturing their potential and fostering holistic development, we contribute to the country's aspirations of remaining competitive in a globalized world. This strategic investment in human capital is vital for driving innovation, advancing technology, and, ultimately, ensuring sustainable growth and prosperity (Banmairuroy et al., 2022; Wongwuttivat & Lawanna, 2018). Moreover, it is imperative to recognize that the developmental needs of children and youth evolve, necessitating continuous adaptation and refinement of educational and social policies (Howard et al., 2019). Therefore, efforts to enhance the quality of education and holistic development must remain responsive to the shifting socio-economic dynamics and emerging challenges. Through such proactive measures, we empower individuals to realize their full potential and lay the foundation for a resilient and progressive society.

Therefore, one of educational management's primary objectives is to develop learners' potential fully. Educational institutions must seek avenues to promote and cultivate learners' readiness to thrive in the 21st-century world (Luna Scott, 2015). Early childhood represents a pivotal stage for learning, as it is a period when the brain undergoes significant development, shaping intelligence, personality, and emotional intelligence (Kohlberg, 1968). The development of children during this crucial stage is fundamental for enhancing skills and capabilities to a higher level, ultimately shaping them into quality adults and pivotal assets for the nation's ongoing development. Therefore, investing in early childhood human resource development is deemed the most worthwhile investment, with returns as high as sevenfold in the future (Heckman, 2012; Immordino-Yang, 2019). Aside from academic performance, one indicator of children's readiness is their executive function skills. Children with strong executive function skills demonstrate the ability to accomplish tasks, solve problems using various methods, and engage in collaborative work with others joyfully (Ernst & Burcak, 2019). According to the October 2016 developmental report on executive function in preschool children by the Neuroscience Research Center and the National Institute for Child and Family Development, a study involving 2,965 children aged 2-6 across all regions of the country found that 30 percent of children exhibited below-average executive function behavior. These children struggled with self-regulation, impulsivity, waiting, restlessness, and difficulty completing tasks. (Lertladaluck et al., 2021; Likhitweerawong et al., 2023)

Preschool-aged children's executive function (EF) skills, spanning ages 2 to 6, encompass five foundational dimensions: working memory, inhibitory control, shift/cognitive flexibility, emotional control, and planning/organization (Christ et al., 2020). Each facet exhibits distinct developmental progressions throughout these formative years. Working memory evolves as children mature, enabling them to hold and manipulate information more effectively. Inhibitory control gradually strengthens, allowing them to inhibit impulsive actions and regulate their behavior. Shift/cognitive flexibility develops steadily, fostering adaptability and task-switching capabilities. Emotional control advances as children learn to manage their emotions more adeptly over time (Cowan, 2014; Gathercole & Packiam, 2008). Lastly, planning and organization skills emerge, facilitating effective task management and execution. Recognizing these developmental trajectories aids educators and caregivers in fostering children's EF skills across the early childhood years (Allen et al., 2015). Moreover, according to Zelazo et al. (2016), these three fundamental components essential for the progression towards executive function (EF) skills in various domains are delineated: 1. Working memory, which initiates its developmental trajectory as early as one year of age. 2. Inhibitory control, a cognitive facet typically begins to mature around 3 to 3.5 years. 3. Shift/cognitive flexibility is a cognitive attribute that emerges concomitantly with proficient working memory and inhibitory control. Notably, all three aforementioned components manifest remarkable advancement rates within the developmental span from ages 3 to 5 years (Tang et al., 2016). If children aged 3-5 years exhibit executive function (EF) skills below the average threshold, as indicated by assessment results with T scores <45, it signifies a developmental lag necessitating intervention. These children may demonstrate impulsive behaviors, restlessness, difficulty waiting, short attention spans, and susceptibility to frustration. In the long term, such tendencies can impact their learning, work performance, and social interactions or even increase the risk of incomplete education, aggressive behavior, substance abuse, and involvement in criminal activities.

Given the background and significance of the aforementioned issues, it becomes imperative to identify the causes and strategies to promote executive function (EF) skills in preschool children. This necessitates conducting a comprehensive needs assessment across all three educational sectors in Nonthaburi province: the basic education commission, the private education promotion commission, and local administrative organizations. Utilizing a Complete Needs Assessment approach, the findings will provide insights into promoting EF skills from the teachers' perspective, who play a pivotal role in direct student engagement and instructional management. Subsequently, these insights will inform actionable strategies that are aligned with teachers' needs and conducive to practical implementation in schools.

1.2 Research Objectives

1. To identify the necessary needs for developing executive function (EF) skills in preschool children across all three educational sectors in Nonthaburi province: the basic education commission, private education promotion commission, and local administrative organizations.
2. To analyze the underlying reasons for the essential requirements in promoting executive function skills in preschool children within kindergarten schools in Nonthaburi province.
3. To delineate guidelines for promoting executive function skills in preschool children within schools in Nonthaburi province.

1.3 Research Scope

This research aims to conduct a comprehensive needs assessment comprising three components: 1) Needs identification: Identifying the essential requirements for developing executive function (EF) skills in preschool children currently enrolled in kindergarten schools in Nonthaburi province. 2) Needs analysis: Analyzing the underlying reasons for the requirements to promote executive function skills in preschool children. 3) Needs solution: Formulating guidelines for promoting executive function skills in preschool children within schools. The scope encompasses assessing the requirements based on teachers' perceptions regarding children's behaviors. The target population includes teachers from all three educational sectors: the basic education commission, the private education promotion commission, and local administrative organizations in Nonthaburi province.

1.4 Population and Sample

The population for this study includes kindergarten teachers teaching in schools at the kindergarten level in Nonthaburi province across three educational sectors: the Office of the Basic Education Commission (OBEC), the Office of the Private Education Commission (OPEC), and local administrative organizations. The total population consists of 8,296 teachers. The population comprises preschool children attending kindergarten schools in Nonthaburi province, aged between five years and five years 11 months, totaling 28,621 children from 239 schools (Nonthaburi Provincial Education Office, 2022).

The researchers utilized the Krejcie and Morgan (1970) table to determine the sample size. According to the table, a sample size of preschool children should be at least 379 individuals. Consequently, the sample size for preschool children was 379 per sample group. Each sample group consists of 12 preschool children per classroom. The sampling details are as follows:

1. Stratified random sampling was used based on the educational sector of schools in Nonthaburi province, including OBEC, OPEC, and local administrative organizations, for a total of three sectors.
2. Stratified random sampling based on the grade level of schools within each sector in Nonthaburi province, including two schools for OBEC, two for OPEC, and two for local administrative organizations, totaling six schools.
3. Stratified random sampling based on the classroom level within each school, including all 12 classrooms across the six selected schools.

The number of sample groups of preschool children categorized by the affiliation of the schools and the proportion of the actual sample groups obtained are as follows: affiliated with the Office of the Basic Education Commission, consisting of Anubanbangkruay School (Wat Sriprawat) and Anurajaprasit School; affiliated with the Office of the Private Education Commission, consisting of Chonprathanwittaya School and Phraharuthai Nonthaburi School; and affiliated with the Department of Local Administration, consisting of Sao Thong Hin School and Plai Bang Wat Sunthon Thammikaram Municipal School. The sample groups include children aged 5 to 5 years and 11 months, totaling 328 individuals, with 162 males and 166 females.

However, data collection revealed that the research has a participation rate of 86.52%, with a sample group of 328 individuals, which is lower than the minimum sample size required. This constitutes a limitation of the research at this stage.

Table 1. Summarizes the number of students in the research sample

Affiliation	Students			
	Population (person)	Expected Sample (person)	Actual Sample (person)	Sample (Percentage)
Office of the Basic Education Commission	7177	120	110	29.02
Office of the Private Education Commission	15481	150	122	32.18
Department of Local Administration	5963	109	96	25.32
Total	28621	379	328	86.52

1.5 Conceptual Framework of the Study

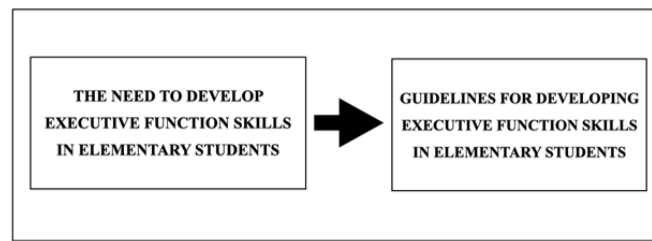


Figure 1. Conceptual Framework of the Study

2. Research Methodology

2.1 Research Procedure

This study consists of three research steps, starting with:

Step 1: Needs Identification. This step involves identifying the necessary needs for developing executive function skills among preschool children enrolled in kindergarten-level schools in Nonthaburi province. It encompasses all three affiliations: the Office of the Basic Education Commission, the Office of the Private Education Commission, and local administrative organizations. The sample group consists of 12 teachers from all three affiliations: the Office of the Basic Education Commission, the Office of the Private Education Commission, and local administrative organizations, currently teaching students aged 5-6 years in kindergarten level 3. The key informants are students in regular classrooms of the sampled teachers, comprising 162 males and 166 females, totaling 328 individuals.

Step 2, Needs analysis. This step involves analyzing the causes of the need to promote executive functioning skills in preschool children through group discussions with 12 teachers, covering all three affiliations. The number is sufficient to serve as representatives for providing information. The researchers follow the principles outlined by Nastasi and Schensul (2005), which set a minimum criterion of 5 people.

Step 3, Needs solution. This step involves establishing guidelines for promoting executive functioning skills in preschool children through group discussions with the same group of 12 teachers.

2.2 Constructing and Validating the Quality of Research Instruments

Constructing and verifying the quality of research tools involves several steps to ensure their reliability and validity. Initially, researchers develop or select appropriate instruments based on the research objectives and literature review. Subsequently, pilot testing is conducted to assess the items' clarity, comprehensibility, and relevance. This phase helps identify any ambiguities or issues with the instruments, which can then be refined or revised accordingly. After refining the tools, content validity is assessed through expert review to ensure that the items adequately measure the intended constructs. Additionally, reliability testing is conducted to evaluate the consistency and stability of the instruments over time. This may involve measures such as internal consistency (e.g., Cronbach's alpha) and test-retest reliability. Once the tools have been validated and refined, they are ready for use in the main study. Throughout the research process, ongoing monitoring and evaluation of the instruments are essential to maintain their quality and integrity.

2.3 Data Collection and Data Analysis

In this research step, the researcher prepared a request letter to collect data and requested analysis from representative kindergarten schools of all three sectors: Office of the Basic Education Commission (OBEC), Office of the Private Education Commission (OPEC), and local administrative organizations. The data was collected from teachers who served as key informants and evaluated their students using the Developmental Assessment of Executive Function in Preschoolers (MU.EF-101). Subsequently, the data was analyzed by comparing it with standards to assess the level of executive function development in students aged 5-5.11 years using one-sample t-test statistics. The criteria for analysis were T scores <56, indicating moderate executive function development, and T scores <45, indicating the need for development. This indicated that the executive function development level of students aged 5-5.11 years could have been slightly more timely than the average standard. Following this, volunteer teachers from the sample group collectively analyzed the causes leading to the necessity of promoting executive function skills in kindergarten students in Nonthaburi province by analyzing fishbone diagrams and outlining guidelines for promoting executive function skills of kindergarten

students in schools in Nonthaburi province through group discussions. Data was collected on June 17, 2023, from 16:00 to 19:30 at the Department of Educational Administration, Kasetsart University, and the collected data was then analyzed for content.

3 Data Results

Guidelines for promoting managerial thinking skills of preschool children in schools in Nonthaburi province: A comprehensive needs assessment is presented in two parts. Part 1 outlines the results of identifying the necessary needs for developing managerial thinking skills of preschool children currently enrolled in kindergarten schools in Nonthaburi province. Part 2 presents the results of analyzing the causes leading to the need to promote managerial thinking skills and setting guidelines for promoting managerial thinking skills of preschool children in schools in Nonthaburi province.

Part 1: Results of Identifying the Necessary Needs for Developing Managerial Thinking Skills of Preschool Children Currently Enrolled in Kindergarten Schools in Nonthaburi Province.

Table 2. The raw scores of executive function development in terms of working memory, inhibition, and cognitive flexibility

Gender	Factors	N	\bar{x}	SD	Min	Max
Male	Working memory	162	17.22	3.06	5.00	21
	Inhibition and behavior control	162	19.43	4.40	9.00	28
	Cognitive flexibility	162	10.66	2.53	4.00	15
Female	Working memory	166	16.05	3.78	8.00	23
	Inhibition and behavior control	166	25.31	8.30	11.00	39
	Cognitive flexibility	166	11.02	2.57	6.00	16
Total	Working memory	328	16.63	3.49	5.00	23
	Inhibition and behavior control	328	22.41	7.28	9.00	39
	Cognitive flexibility	328	10.84	2.55	4.00	16

From Table 2, the raw scores obtained from measuring executive function skills in 328 elementary students revealed that the average raw score for working memory was 16.63 out of a total of 24 points, for inhibition was 22.41 out of 40 points, and for cognitive flexibility was 10.84 out of 20 points. The meaning of the raw scores for each domain was not clear, so they were converted into standard scores (T-Scores). The results are presented in Table 3.

Table 3. T-Scores of executive function development in terms of working memory, inhibition, and cognitive flexibility of elementary school children when compared to the criteria

Level	Working Memory		Inhibition of Behavior		Cognitive Flexibility	
	Male	Female	Male	Female	Male	Female
Excellent	0	0	0	14	0	0
Good	70	26	0	24	0	0
Fair	79	114	87	51	83	47
Needs Improvement	9	16	48	47	46	85
Requires Adjustment	4	10	27	30	33	34

From Tables 2 and 3, it is found that among the 328 elementary school children aged 5 to 5 years 11 months, the results of executive function development assessments in terms of working memory show that 14 children are in the "needs improvement" level, 25 children are in the "needs development" level, 193 children are in the "average" level, and 96 children are in the "good" level. Regarding the assessment results for inhibition and impulse control, 57 children are in the "needs improvement" level, 95 children are in the "needs development" level, 138 children are in the "average" level, 24 children are in the "good" level, and 14 children are in the "excellent" level. As for the assessment results for cognitive flexibility, 67 children are in the "needs improvement" level, 131 children are in the "needs development" level, and 130 children are in the "average" level. There are no elementary school children in the "good" or "excellent" levels.

Table 4. Comparison of executive function development among elementary school children studying in kindergarten schools in Nonthaburi province in terms of working memory and inhibition when using the statistical test with T<56

	t	df	M (SD)	P	Mean Difference	Test Value = 56	
						95% CI	
						Lower	Upper
Working Memory	-14.6	327	50.9 (6.3)	.00	-5.1	-5.7	-4.4
Inhibition and Behavioral Control	-23.7	327	46.9 (6.9)	.00	-9.1	-9.8	-8.3

*p < 0.05

From Table 4, it is evident that in comparing the executive function development of elementary school children studying in kindergarten schools in Nonthaburi province with the criterion of T<56 for executive function skills in terms of working memory and inhibition, the scores are significantly lower than the criterion for the excellent level at a statistically significant level of .05.

Table 5. Comparison of executive function development of elementary school children studying in kindergarten schools in Nonthaburi province in terms of cognitive flexibility when using the T<45 statistical test

	t	df	M (SD)	P	Mean Difference	Test Value = 45	
						95% CI	
						Lower	Upper
Cognitive Flexibility/Shifting	-5.1	327	43.6 (4.9)	.00	-1.4	-1.9	-0.8

*p < 0.05

From Table 5, it is observed that in comparing the executive function development of elementary school children studying in kindergarten schools in Nonthaburi province with the criterion score of T<46 for cognitive flexibility, it was found to be significantly lower than the intermediate-level criterion at a statistical significance level of .05.

The results from identifying the necessity to develop executive function skills in elementary school children studying in kindergarten schools in Nonthaburi province, across all three affiliations, namely, under the supervision of the Basic Education Commission: Bang Krui Kindergarten School (Wat Sri Pravat), Anurakprasis School, under the supervision of the Private Education Promotion Office: Chonprathan Witthayakam School, and Phrae Hua Thainonburi School, under the supervision of the Local Administrative Organization: Saengthonghin Municipality School and Plai Bang Wat Sunthornthammikanaram Municipality School, assessed by teachers using the Executive Function Development Assessment for Preschoolers (MU.EF-101), revealed that the level of executive function development in students aged 5 to 5 years 11 months was slight to significantly delayed compared to the average standard.

Part 2: Analysis of the Causes of the Necessity to Promote Executive Function Skills in Elementary School Children

Analysis of the Causes Leading to the Necessity to Promote Executive Function Skills in Elementary School Children in Nonthaburi Province was conducted by gathering data from discussions with groups of teachers representing all three affiliations: the Basic Education Commission Office with four teachers, the Private Education Promotion Office with four teachers, and local administrative organization-affiliated schools with four teachers, totaling 12 participants. The analysis of the causes was conducted using the fishbone diagram technique and can be divided into three main categories as follows:

1. *Management Thinking Skills in Working Memory:* From the requirements analysis, participants ranked the importance of the causes into the top three. It was found that the most significant cause is that parents do not provide opportunities for children to do things by themselves. This often leads to dependency on technology or caregivers, where children don't need to receive or memorize instructions for daily tasks. Following that is the predominance of academic activities, such as reading and writing exercises, and the heavy workload of teachers, leaving little time to prepare materials or design new activities.

2. *Management Thinking Skills in Stopping and Suppressing Behavior:* From the requirements analysis, participants ranked the importance of the causes into the top three. It was found that the most significant cause is that teachers lack knowledge and understanding in organizing activities to promote management thinking skills in stopping and suppressing behavior. Following that is how parents immediately fulfill children's desires

without setting conditions or rules for play or specifying playtime. Rapid technological changes, which are modern and easily accessible, allow children quick access without waiting.

3. Management Thinking Skills in Flexibility and Adaptability: From the requirements analysis, participants ranked the importance of the causes into the top three. It was found that the most significant cause is that teachers fear mistakes, thus rarely allowing children to think and make decisions on their own or try new things. Following that is how parents decide everything instead of letting children encounter problems and decide for themselves. Children stay in the same environment without adapting their behaviors to changing situations.

Part 3: Results of Establishing Guidelines for Promoting Executive Function Skills in Early Childhood

The results of establishing guidelines for promoting executive function skills in early childhood through group discussions with 12 kindergarten teachers are as follows:

1. Promoting executive function skills in terms of memory during work has strategies divided based on necessary needs as follows:

Approach 1: Parents should cooperate in helping children practice doing various things by themselves, such as allowing children to assist themselves according to verbal instructions.

According to Approach 1, kindergarten teachers provided feedback that this approach is suitable and feasible. Since children spend only five days a week at school and the remaining two days with parents at home, training should occur at home and school. However, this approach might be less feasible because parents often hesitate to let children do things alone, fearing slowness and wasting time, sometimes leading to children not receiving the appropriate level of assistance in their daily lives.

Approach 2: Plan learning activities appropriately for children's development by analyzing children's peer assessment results to determine learning activities based on the children's context.

From Approach 2, kindergarten teachers commented that this approach is suitable and feasible. Teachers can design learning activities for children while considering the alignment with the curriculum standards.

Approach 3: Schools should help provide easy-to-use teaching materials, with clear steps and usage instructions that are not overly complex, to attract interest and promote children's executive function development.

From Approach 3, kindergarten teachers provided feedback that this approach is suitable and feasible. Currently, readily available teaching materials are easily obtained and visually appealing.

2. Promoting executive function skills in stopping and inhibiting behaviors has strategies divided based on the necessary needs as follows:

Approach 1: Schools should conduct training sessions to teach kindergarten teachers about promoting children's executive function skills.

According to Approach 1, kindergarten teachers commented that this approach is suitable and feasible. Typically, schools organize training sessions or support teachers to attend training each academic term. However, specific training for promoting children's executive function skills through activities might need to be arranged.

Approach 2: Parents should collaborate with teachers to help train children to wait and only sometimes give in to their desires. For instance, if a child wants to play with an iPad, conditions should be set for the child to wait for an appropriate time to use it, and specific time limits should be established for screen time. If the child desires to play but it's not time, they should be made to wait.

From Approach 2, kindergarten teachers provided feedback that this approach is suitable and feasible. However, it might be less feasible because parents often work and have limited time to engage in activities with their children. Consequently, children are often left with media, technology, or toys during their parents' working hours, and time limits for play are not commonly enforced.

Approach 3: Schools should provide appropriate materials that support children's development and help promote executive function skills, such as toys or equipment that teach children to stop and inhibit behaviors. Teachers or parents can easily access these materials with little difficulty.

From Approach 3, kindergarten teachers commented that this approach is suitable and feasible. If children can be quickly engaged with materials that divert their attention from changing media and technology, it will help them develop stopping and inhibiting behaviors. However, this approach might be less feasible because teachers and parents increasingly rely on technology to facilitate teaching activities.

3. Promoting executive function skills in terms of flexibility and adaptability in thinking has strategies divided

based on necessary needs as follows:

Approach 1: Teachers should encourage children to think and make decisions independently. If mistakes occur, they should encourage the children.

According to Approach 1, kindergarten teachers provided feedback that this approach is suitable and feasible. Teachers have the desire to promote children's development in all aspects.

Approach 2: Teachers should collaborate with parents to help train children to think and make decisions independently. Children should be encouraged to do things by themselves, starting with helping themselves in daily life, such as choosing clothes or dressing themselves.

From Approach 2, kindergarten teachers commented that this approach is suitable and feasible. Since children spend only five days a week at school and the remaining two days with parents at home, training should occur at home and school. Parents can assist with encouraging children to engage in activities independently, starting with simple tasks like choosing their outfits.

Approach 3: Teachers should provide tools to facilitate teaching that are easy to use, adaptable, and can be applied in various situations.

From Approach 3, kindergarten teachers provided feedback that this approach is suitable and feasible. Creating a conducive learning environment will aid children's development, and adapting new environments will attract children's interest. However, this approach might be less feasible due to teachers' heavy workload, leaving little time to constantly create new environments.

This is based on the strategies for promoting executive function skills in preschool children in Nonthaburi province, as provided by kindergarten teachers.

4. Research Discussions

The discussion of the research results focuses on promoting executive function skills in all three aspects: 1. Memory during work, two—inhibition and regulation of behavior, and 3. Cognitive flexibility. The detailed discussion of the research results is as follows:

The first issue, regarding memory during work, suggests that teachers and parents should collaborate to help children engage in various activities independently. This collaboration aims to stimulate the child's memory retention and physical movement development. According to Best (2010), when children use their muscles to move, participate in activities, or perform tasks independently, it stimulates and enhances the development of their cognitive and executive functions directly. This leads to better stimulation and development of the brain's frontal lobe, which is responsible for executive functions. Additionally, research has shown that the nervous system changes during physical activity, producing factors that influence brain and nervous system development. The growth of the nervous system changes in conjunction with neurotransmitter processes due to increased blood flow to the brain during various activities. This influences the development of the frontal lobe, which is responsible for executive functions such as decision-making and behaviors related to executive function (Otero & Barker, 2013). Furthermore, teachers and parents should collaborate to realize the potential for child development fully. Grolnick and Slowiaczek (1994) stated that the involvement of parents in the development of young children has a positive correlation. The more parents are involved, the more influential the child develops. This is consistent with LaRocque et al.'s (2009) concept of parental involvement and collaboration with teachers in promoting children's learning, emphasizing the importance of the two leading institutions, the family and the educational institution, which play a crucial role in child development.

The second issue, concerning stopping and inhibiting behaviors, suggests that parents should collaborate with teachers to reduce access to media or limit the time children spend using technology. Additionally, they should train children to learn patience. This is because smartphones provide rapid access to technology, particularly among young children. Gazzaley and Rosen (2016) emphasize that smartphones are centers for fast-paced and captivating technology, which makes children accustomed to and expecting quick responses to their desires, similar to the technology they use. Children who are attached to smartphones often exhibit behavioral issues such as irritability, impatience, lack of tolerance, impulsive behavior, and even a tendency towards symptoms of Pseudo-ADHD due to constant brain stimulation, leading to overexcitement and desensitization to stimuli. Conversely, cautious smartphone use may benefit children. For example, Middelweerd et al. (2015) found that smartphone use may increase students' awareness of the time spent exercising, positively affecting overall exercise levels. Further research should examine the relationship between smartphone use, time spent on exercise, intensity of exercise, and total daily exercise.

The third issue, concerning flexibility and adaptability, suggests that teachers must encourage children to think independently. The promotion strategy involves allowing children to make decisions and providing schools with easy-to-use teaching aids that can be adapted to various situations. Darling-Hammond and Cook-Harvey (2018) explain that schools should manage relationships between teachers and parents and create environments conducive to children's learning and development. This includes developing children through appropriate play and activity-based learning, promoting learning experiences, and fostering children's confidence in their thinking skills. Therefore, collaboration between school administrators, teachers, and parents in creating an environment that promotes children's learning is essential for promoting executive function skills in children. Additionally, Zelazo et al. (2008) explain the development of executive function skills, stating that during various activities, children may encounter unexpected situations or novelty. In such situations, previously learned behaviors that have become automatic may not work anymore, requiring selecting information to adapt and respond to new and unfamiliar situations. The nature of new situations requires children to change behaviors by stopping what they are doing to generate responsive behaviors and make different decisions. These behaviors can be considered manifestations of cognitive flexibility and adaptability.

5. Research Implications

1. **Parent-Teacher Collaboration in Skill Development:** Research should explore the effectiveness of collaborative efforts between parents and teachers in promoting executive function skills in children. Investigating the impact of joint interventions and strategies employed by parents and teachers could provide insights into optimizing skill development outcomes.
2. **Impact of Technology Use on Executive Function Skills:** Further research is needed to examine the relationship between children's use of technology, particularly smartphones, and their executive function skills. Exploring how excessive screen time affects self-regulation, attention, and cognitive flexibility could inform interventions to mitigate potential adverse effects.
3. **Environmental Factors in Learning Environments:** Studies should investigate the influence of learning environments, including the availability of teaching aids and the level of adaptability in instructional materials, on children's executive function skills. Understanding how environmental factors facilitate or hinder skill development can guide the design of more conducive learning settings.
4. **Longitudinal Studies on Skill Development:** Long-term longitudinal studies tracking children's executive function skills from early childhood through adolescence could provide valuable insights into the trajectory of skill development and its implications for academic achievement, social competence, and overall well-being. Identifying critical periods and factors influencing skill acquisition can inform targeted interventions and support strategies.

6. Research Suggestions

1. **Longitudinal Study:** Initiate a longitudinal study to track the development of executive function skills in early childhood students from preschool through adolescence. By examining the trajectory of executive function development over time, we can better understand its impact on academic performance, social interactions, and overall well-being.
2. **Parental Involvement Interventions:** Design and implement interventions to enhance parental involvement in fostering executive function skills in early childhood students. Explore diverse strategies for engaging parents in activities that promote working memory, inhibitory control, and cognitive flexibility, and assess the effectiveness of these interventions on children's executive function development.
3. **Cultural Adaptation and Validation:** Adapt existing executive function assessment tools to suit the cultural context of Nonthaburi Province and validate their reliability and validity for assessing executive function skills in early childhood students within this population. This step ensures that assessment measures accurately capture the nuances of executive function development in the local context.
4. **Teacher Training and Professional Development:** Develop training programs for kindergarten teachers to enhance their understanding of executive function development and equip them with practical strategies for promoting these skills in early childhood students. Evaluate the impact of these programs on teacher practices and student outcomes.
5. **Intervention Implementation and Sustainability:** Explore strategies for scaling up the implementation of executive function interventions in early childhood education settings. Investigate factors that facilitate or hinder the sustainability of these interventions over time, including resource allocation, institutional support, and stakeholder engagement. This research will inform efforts to integrate executive function skill development into

routine educational practices on a broader scale.

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Authors contributions

In this study, Dr. Nattika Penglee and Dr. Thanarachathapoom led the study design and revision processes, ensuring methodological rigor and scholarly integrity. They provided critical insights, guided data collection and analysis, and contributed to drafting and revising the manuscript. There were no special authorship arrangements, and all authors reviewed and approved the final manuscript.

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Competing interests

The authors declare no competing interests.

Informed consent

Informed consent was obtained from all participants involved in this study.

Ethics approval

Ethics approval for this study was obtained from the Kasetsart University Research Ethics Committee (COA No. COA65/052, Approval date: 01 August 2022).

Provenance and peer review

The manuscript underwent internal review by the authors' research team before submission to ensure accuracy and coherence. Subsequently, it was peer-reviewed by experts in the field, whose feedback and suggestions were incorporated into the final version.

Data availability statement

The data supporting this study's findings are available from the corresponding author upon reasonable request. Restrictions apply to the availability of these data, which were used under license for the current study and are not publicly available. However, data are available from the authors upon reasonable request and with permission from the relevant ethics committees.

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