

Effects of the Guardian Participatory Learning Program on Executive Function Development in Early Childhood: Administered in Child Development Centers in Eastern Thailand

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Abstract:

Objective: To examine the effects of a participatory learning program for guardians on the development of executive function (EF) in early childhood. The study was conducted at child development centers in Mueang District, Chonburi Province.

Material and Methods: This quasi-experimental study involved 60 guardians of young children, recruited from two centres and analysed according to each centre's designation (30 participants per group), with no randomization at either centre or the individual level. The intervention was designed utilizing Kolb's Experiential Learning Theory. The experimental group participated in five structured EF-focused learning activities delivered weekly over five weeks. In contrast, the control group received standard educational sessions provided by local agencies. Data collection instruments included a demographic questionnaire, a knowledge test, attitude and childrearing behavior questionnaires, and a tool for evaluating children's EF. Descriptive statistics were used to analyze general characteristics, and paired sample t-tests and independent sample t-tests were employed to compare pre- and post-intervention outcomes within and between groups.

Results: Participants in the experimental group showed significantly higher levels of knowledge, attitude, childrearing behavior, and EF development in their children compared to both their pre-intervention scores and those of the control group (p-value<0.05).

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Conclusion: The program's effectiveness demonstrates its potential to be a practical tool for public health personnel. The program may be adapted to local contexts. Further studies with a prolonged follow-up are recommended to evaluate the sustainability of childrearing behaviors.

Keywords: early childhood development, executive function, guardian, participatory learning

Introduction

Early childhood development is recognized as a national priority and serves as the foundation for lifelong learning. The 13th National Economic and Social Development Plan (2023–2027) promotes comprehensive support from pregnancy through preschool by enhancing guardian preparedness and fostering cross-sectoral collaboration¹. However, as of 2024, 21.52% of Thai children aged 0–5 years were suspected of overall developmental delay, particularly in language, with a rising trend^{2,3}. These figures highlight ongoing concerns regarding the quality of early childhood development and the need for targeted interventions to strengthen cognitive and emotional growth during this critical stage.

Executive function (EF), which includes self-regulation, decision-making, and problem-solving, is vital during early childhood, a key period for emotional and behavioral development. Children with strong EF are better able to learn, adapt, and socialize^{4,5}. In Thailand, around 30% of children exhibit below-standard EF, particularly in attention and inhibitory control⁶. A study in Chonburi Province, an eastern region of Thailand, found that preschoolers scored an average of 57.28 (S.D.=7.34) on the MU.EF-101 assessment, which was considered “good”. However, this performance did not meet the optimal goal, namely achieving the “very good” level⁷. Despite this, many guardians still lack the knowledge, attitudes, and caregiving skills needed to foster EF. This gap is especially concerning in a fast-paced environment, where reduced parent-child interaction may hinder EF development^{6,8,9}. Parenting that

encourages experiential learning, emotional support, and shared decision-making is essential¹⁰. Kolb's Experiential Learning Theory supports this approach through four stages, including Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation. This approach helps turn daily experiences into lasting cognitive and behavioral growth¹¹.

Literature reviews show that early childhood EF development has mainly focused on children and teacher-led interventions, while studies on guardian roles remain limited despite the growing use of active learning approaches^{12,13,14,15}. In Chonburi Province, although children generally exhibit adequate EF, gaps in guardian knowledge, attitudes, and practices pose challenges to optimal development^{7,16}.

In response to these gaps, we evaluated a guardian participatory learning program in child development centers in Chonburi, with a primary focus on improving guardians' executive function-related knowledge, attitudes, and caregiving practices. The primary (proximal) objective was to improve guardians' EF-related knowledge, attitudes, and caregiving practices (KAP) using Kolb's Experiential Learning Theory operationalized through observe, reflect, conceptualize, and experiment. A distal objective was to examine potential spillover effects on children's EF arising from enhanced guardian KAP. Accordingly, analyses focused on improvements in guardians' KAP as the primary outcomes, while children's executive function was assessed as a subsequent outcome.

Material and Methods

Methodology and data collection procedure

This study employed quasi-experimental research with a pretest-posttest two-group design, consisting of an experimental group and a control group. The study participants were 60 guardians of children in early childhood (aged 2–5 years) recruited from two centres and analysed according to each centre's designation (30 participants per group). This study used a non-randomized recruitment approach: two child-development centers with similar socio-cultural contexts were purposively selected as study sites. After site selection, we randomly assigned the study condition at the center level using simple random sampling (lot drawing): one center was allocated to the intervention and the other to the control. No individual-level randomization was performed. The intervention was developed based on Kolb's Experiential Learning Theory, incorporating four sequential stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation. These stages were systematically applied to enhance childrearing practices that support the development of EF in early childhood. The experimental group participated in five structured EF-focused learning sessions conducted weekly over a five-week period (one session per week, approximately 60 minutes each). In contrast, the control group received only the standard educational activities, typically provided by local child development and public health centres (Each session lasted approximately 30–45 minutes, totaling 2–3 sessions throughout the five-week study period). Data collection was carried out from January to March 2025. Pre-intervention data were collected in Week 1; Weeks 2–6 involved the implementation of the intervention sessions, and post-intervention data were collected in Week 7, using standardized research instruments. The implementation process of the participatory learning program is illustrated in Figure 1.

The study involved guardians of young children attending childcare centres in Mueang District, Chonburi Province. In 2024, 29 centres were under the administration of Saensuk Municipality. This area was selected as the study site due to its urban characteristics, diverse population, and consistent reports of developmental delays in early childhood that exceeded national benchmarks, making it a relevant and high-need environment for EF-related interventions. Sample size was calculated using Lemeshow's formula, with estimates due to unavailable population parameters¹⁷. A 15% buffer was added to prevent data loss, resulting in 30 participants per group (total $n=60$)^{18,19}. Two centres with similar socio-cultural contexts and high rates of developmental delays were purposively selected; one centre was designated as the intervention site and the other as the comparison site, with no randomization at either the centre or individual level. All eligible guardians within each centre were invited, according to the centre's designation. To ensure group comparability, participants from both the intervention and control groups were matched based on key demographic characteristics, including guardian gender, age, caregiver-child relationship, occupation, education level, household income, and family structure. Inclusion criteria for study participants were: guardians aged ≥ 18 , literate in Thai, able to use communication devices, did not have serious health conditions, and willing to participate. Participants were excluded if they were unable to attend all sessions.

Research instruments

The research instruments consisted of two components: the intervention tool and the data collection tool. Details are as follows:

Intervention tool

The intervention was a guardian participatory learning program designed to enhance EF in early childhood. The program was developed by the research

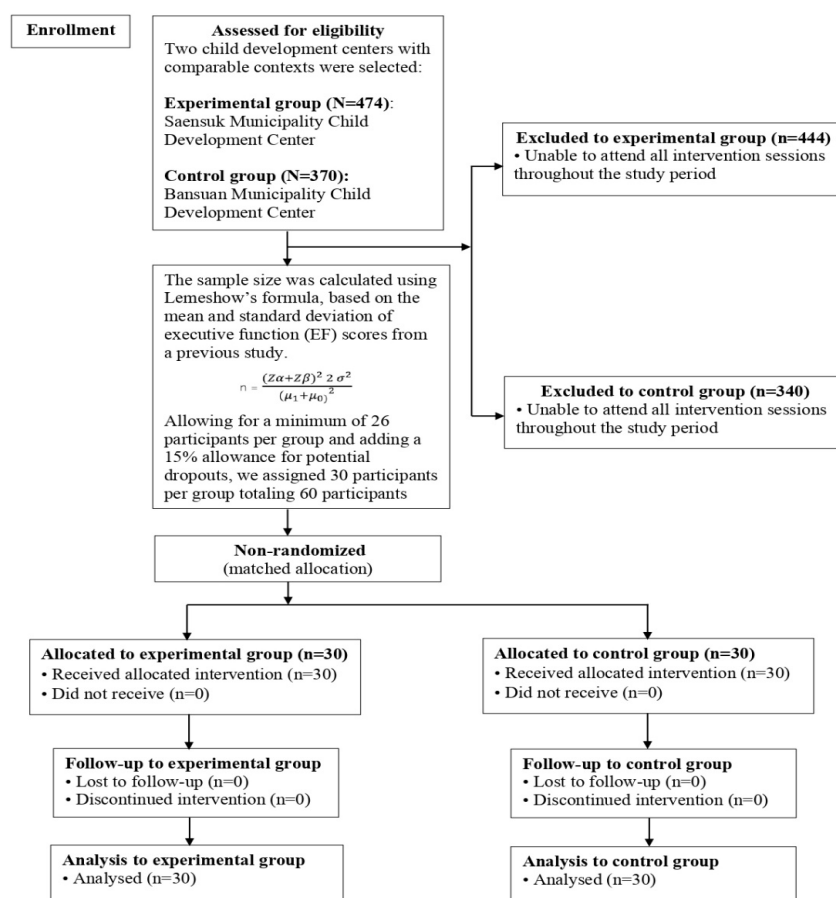


Figure 1 CONSORT flowchart of the intervention

team in collaboration with child development centre teachers, based on the relevant literature and Kolb's Experiential Learning Theory. It comprised five structured weekly sessions (one session per week, approximately 60 minutes each) conducted in small groups on-site at child development centres. The program employed participatory learning methods through short educational videos, guided discussions, and LINE group communication to support continuous engagement.

Each session was designed to cover all four stages of Kolb's experiential cycle: Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation (Figure 2). Details regarding facilitators' training and supervision, delivery setting and procedures,

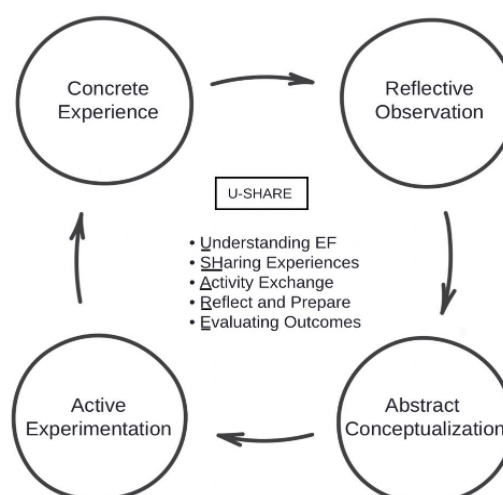


Figure 2 Application of theoretical concepts in program activity design

timing and frequency, session-by-session objectives and activities, materials and homework, and program fidelity are fully described in the Supplement.

Program fidelity was monitored through attendance logs, facilitator checklists, and weekly supervision. The average attendance rate exceeded 90%, and all participants completed all five sessions.

Data collection tool

The instruments used for data collection were pre- and post-intervention questionnaires developed by the researchers based on a review of relevant literature and research. The questionnaire consisted of five sections as follows:

Section 1: demographic information of guardians

This section included seven items: gender, age, relationship with the child, occupation, education level, income, and family structure. The questions were in multiple-choice and fill-in-the-blank formats.

Section 2: knowledge test

This section consisted of 12 true/false items that tested guardians' knowledge of how to build EF skills in their children. Each correct response was scored as 1 point; incorrect responses were scored as 0 points. The total score was interpreted into three levels of knowledge about building EF skills in children based on Bloom's Taxonomy (1956): Low (0–4 points), Moderate (5–9 points), High (10–12 points)²⁰.

Section 3: attitude scale toward parenting for EF Development

This section contained 10 items covering the guardians' attitude about parenting for the development of five different dimensions of EF (2 items per dimension). Responses were rated on a 5-point Likert scale: strongly disagree, disagree, uncertain, agree, and strongly agree. The average scores were interpreted into three levels of guardians' attitude about parenting for the development of

EF in their children, with "high" being a more favorable, positive attitude towards developing EF. Based on Best's criteria, the guardians' attitudes were classified as (1997): Low (10.00–23.33), Moderate (23.34–36.67), High (36.68 and above)²¹.

Section 4: parenting behavior scale for EF development

This section included 10 items covering parenting behavior for developing the five dimensions of EF (2 items per dimension). Responses were rated on a 5-point frequency scale: never, rarely, sometimes, often, and always. The average scores were interpreted into three levels of the guardians' behavior for developing EF in their children; "High" represented reporting the positive behavior that encourages EF development. Based on Best's criteria (1997), the guardians' behavior was categorized as: Low (10.00–23.33), Moderate (23.34–36.67), High (36.68 and above)²¹.

Section 5: executive function development assessment for preschool children (MU.EF-101)

This study employed the MU.EF-101, a standardized tool developed by Mahidol University to assess EF in preschool children aged 2–6 years. Adapted from the BRIEF-P by Isquith et al. (2005), the tool was validated by Jutapakdeekul et al. (2017), with an Index of item objective congruence (IOC) of 0.82 and Cronbach's alpha of 0.77. The instrument consists of 32 items rated by caregivers on a 5-point frequency scale (0=never to 4=every day), covering five EF domains: Inhibitory Control (40 points), Cognitive Flexibility (20), Emotional Control (20), Working Memory (24), and Planning and Organization (24), with a total score of 128. Raw scores are converted into T-scores (mean=50, S.D.=10) and interpreted by age and gender. T-scores >60 indicate that the preschool children of the guardians participating in the study had excellent EF; 56–60 was good; 45–55 was average; 40–44 needs development; and <40 needs improvement⁶.

Instrument validation

Content validity of the intervention program and questionnaires was assessed by three experts in developmental psychology, cognitive science, and health education. Following expert review and revisions, all instruments were pilot-tested with 30 guardians of early childhood children from Mheung Subdistrict Municipality Child Development Center, who had characteristics and community contexts similar to the target population. Item-objective congruence (IOC) scores were 0.96 for the program materials and 0.77 for the questionnaires (item range 0.75–0.86). Reliability was acceptable: knowledge scale KR-20=0.81 (item difficulty 0.70–0.80, discrimination 0.30–0.60); attitude Cronbach's α =0.78; behavior Cronbach's α =0.88.

Data collection

Data were collected from January to March 2025. The researchers coordinated with Saensuk Municipality and Bansuan Municipality to obtain permission for data collection at their respective childcare centres. Pre- and post-intervention data were collected in Weeks 1 and 7. All data were collected on-site with consent and confidentiality maintained.

Data analysis

To compare the differences in the mean scores of guardians' knowledge regarding parenting to promote early childhood EF, guardians' attitudes toward parenting for promoting early childhood EF, parenting behaviors for promoting early childhood EF, and children's EF development within the experimental and control groups before and after participating in the program, the Paired Samples t-test was used.

To compare the differences in the mean scores of guardians' knowledge regarding parenting to promote early childhood EF, guardians' attitudes toward parenting for promoting early childhood EF, parenting behaviors

for promoting early childhood EF, and children's EF development between the experimental and control groups before and after participating in the program, the Independent Samples t-test was used.

Since the data distribution had been tested, the data were found to be normally distributed using the Shapiro-Wilk test and the Practical Test Technique, which showed that the mean minus the standard deviation was greater than 0, the skewness was less than ± 3 , and the kurtosis was less than ± 10 . The Shapiro-Wilk test was used because the sample size was 30 participants.

Results

Participant demographics

Both groups shared identical baseline demographic profiles due to matching on key demographic characteristics. The majority were female (86.7%), aged 20–40 years (66.7%), and biological guardians (73.3%). In terms of socioeconomic status, 36.7% were general laborers, 50.0% had basic education (completed lower secondary education), 76.7% reported monthly household incomes between 15,000 and 50,000 Thai baht (THB), and 56.7% lived in extended families.

This matching ensured baseline equivalence across groups prior to the intervention (Table 1).

Parental knowledge regarding EF development in early childhood

Results showed a significant improvement in the experimental group after the intervention (p -value<0.001), while no significant change was observed in the control group (p -value=0.522) (Table 2). Independent sample t -tests revealed no significant difference in baseline knowledge scores between groups (p -value=0.834). However, after the intervention, the experimental group demonstrated significantly higher knowledge scores than the control group (p -value<0.001) (Table 3).

Table 1 Demographic characteristics of the participants

Variables	Experimental group (n=30)		Control group (n=30)	
	Number	Percent	Number	Percent
Gender				
Male	4	13.30	4	13.30
Female	26	86.70	26	86.70
Age group (years)				
Early adulthood (20–40)	20	66.70	20	66.70
Middle adulthood (41–59)	5	16.70	5	16.70
Older adulthood (60 and above)	5	16.70	5	16.70
± S.D.	38.77±12.54		38.00±13.09	
Min–max	25–64		22–64	
Guardian role				
Biological guardian	22	73.30	22	73.30
Non-biological guardian	8	26.70	8	26.70
Occupation				
Homemaker/unemployed	9	30.00	9	30.00
Casual laborer	11	36.70	11	36.70
Self-employed	10	33.30	10	33.30
Education level				
Basic education (graduation from 6 th to 9 th grades)	15	50.00	15	50.00
Above basic education (graduation from 12 th grade or higher)	15	50.00	15	50.00
Monthly household income (Thai baht (THB)/month)				
Less than 15,000	5	16.70	5	16.70
15,001–50,000	23	76.70	23	76.70
More than 50,000	2	6.70	2	6.70
± S.D.	26879.33±19433.62		27123.33±14653.27	
Min–Max	9000–100000		2200–70000	
Family structure				
Nuclear family	11	36.70	11	36.70
Extended family	17	56.70	17	56.70
Single-parent family	1	3.33	1	3.33
Skipped-generation family	1	3.33	1	3.33

S.D.=standard deviation

Attitude toward parenting for EF development

The experimental group showed a significant increase in attitude scores after the intervention (p -value<0.001), while the control group showed no significant change (p -value=0.362) (Table 2). Both groups had similar baseline scores (p -value=0.649), but post-test scores were significantly higher in the experimental group (p -value<0.001) (Table 3).

Parenting behavior for EF development

Following the intervention, participants in the

experimental group demonstrated significantly improved parenting behaviors related to EF (p -value<0.001), while those in the control group showed no significant change (p -value=0.402) (Table 2). Independent sample t -tests indicated no initial difference between the two groups (p -value=0.880). Nonetheless, after the program, the experimental group exhibited substantially higher behavioral scores compared to the control group (p -value<0.001) (Table 3).

Table 2 Within-group comparison of pre- and post-intervention scores on guardians' knowledge, attitudes, behaviors, and children's EF using paired sample t-test

Variables	Pre-intervention (n=30)		Post-intervention (n=30)		Mean difference (95% CI)	t-test	Cohen's d (95% CI)	df	p-value
	$\bar{x}$	S.D.	$\bar{x}$	S.D.					
Knowledge (score range: 0–12)									
Experimental group	6.63	4.19	11.27	2.74	4.64 (4.18, 5.09)	20.85	3.81 (3.43, 4.18)	29	<0.001*
Control group	6.70	4.26	6.80	4.13	0.10 (0.42, 0.65)	0.65	0.12 (–0.50, 0.77)	29	0.522
Attitudes (score range: 0–50)									
Experimental group	24.50	8.98	40.63	7.89	16.13 (15.07, 17.20)	31.01	5.66 (5.29, 6.04)	29	<0.001*
Control group	24.30	9.10	24.13	9.30	–0.17 (–0.53, 0.20)	–0.93	0.17 (–0.53, 0.20)	29	0.362
Behaviors (score range: 0–50)									
Experimental group	22.17	6.61	43.63	14.78	21.46 (19.15, 23.79)	18.92	3.45 (3.08, 3.83)	29	<0.001*
Control group	22.30	6.19	21.87	6.68	–0.43 (–1.47, 0.61)	–0.85	0.16 (–0.53, 0.22)	29	0.402
Executive function (score range: 0–128)									
Experimental group	72.43	7.73	117.20	15.32	44.77 (42.22, 47.31)	35.97	6.57 (6.19, 6.94)	29	<0.001*
Control group	73.63	6.17	72.37	7.34	–1.27 (–3.01, 0.48)	–1.48	–0.27 (–0.64, 0.10)	29	0.149

*p-value<0.05, 95% CI=95% confidence interval, S.D.=standard deviation, df=degrees of freedom

Table 3 Between-group comparison of pre- and post-intervention scores on Guardians' knowledge, attitudes, behaviors, and children's EF using independent sample t-test

Variables	Experimental group (n=30)		Control group (n=30)		Mean difference (95% CI)	t-test	Cohen's d (95% CI)	df	p-value
	$\bar{x}$	S.D.	$\bar{x}$	S.D.					
Knowledge (score range: 0–12)									
Pre-intervention	6.63	4.19	6.70	4.26	0.07 (–0.70, 0.57)	–0.21	0.02 (–0.52, 0.49)	58	0.834
Post-intervention	11.27	2.74	6.80	4.13	–4.47 (3.97, 4.96)	18.15	1.28 (0.72, 1.83)	58	<0.001*
Attitudes (score range: 0–50)									
Pre-intervention	24.50	8.98	24.30	9.10	–0.20 (–0.67, 1.07)	0.46	0.02 (–0.48, 0.53)	58	0.649
Post-intervention	40.63	7.89	24.13	9.30	16.50 (15.48, 17.52)	32.49	1.91 (1.30, 2.53)	58	<0.001*
Behaviors (score range: 0–50)									
Pre-intervention	22.17	6.61	22.30	6.19	–0.13 (–1.89, 1.63)	–0.15	0.02 (–0.53, 0.49)	58	0.880
Post-intervention	43.63	14.78	21.87	6.68	21.76 (20.02, 23.51)	24.98	1.89 (1.28, 2.51)	41.90	<0.001*
Executive function (score range: 0–128)									
Pre-intervention	72.43	7.73	73.63	6.17	–1.20 (–3.25, 0.85)	–1.17	0.17 (–0.34, 0.68)	58	0.245
Post-intervention	117.20	15.32	72.37	7.34	44.83 (42.62, 47.05)	40.51	3.73 (2.89, 4.58)	44.9	<0.001*

*p-value<0.05, 95% CI=95% confidence interval, S.D.=standard deviation, df=degrees of freedom

Executive function in early childhood

The program yielded a notable enhancement in children's executive function among those in the experimental group, as evidenced by a significant increase in EF scores following the intervention (p -value<0.001). In contrast, the control group exhibited no meaningful change (p -value=0.149) (Table 2). Although baseline EF scores were comparable between groups (p -value=0.245), post-intervention analysis revealed a significantly higher EF performance in the experimental group (p -value<0.001) (Table 3), highlighting the program's effectiveness in promoting cognitive development in early childhood.

Discussion

The findings showed that the experimental group had significantly higher post-intervention scores in knowledge, attitudes, and parenting behaviors for promoting EF in early childhood, as well as children's EF, compared to the control group. These outcomes suggest that the participatory learning program effectively enhanced guardians' understanding, shifted attitudes, and improved parenting practices that support children's EF development. The control group, which received only standard information from local services, showed no significant change, indicating that structured participatory activities played a key role in producing positive outcomes. Baseline characteristics between groups were matched and not significantly different, supporting that the observed improvements were due to the intervention. These results are consistent with prior studies by Sriburom et al.¹⁹ and Channgam et al.²², which also reported improvements in parenting behaviors and child development after participating in structured, family-based programs. After participating in the program, the experimental group showed significantly higher mean scores in knowledge, attitudes, and parenting behaviors related to promoting EF in early childhood, as well as children's EF development. These outcomes can be attributed to the program design, which integrated Kolb's Experiential Learning Theory (1984), consisting of

four stages: Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation. The continuous learning cycle enabled guardians to construct new knowledge through hands-on practice, adapted to their real-life context. The program began with the activity "Understanding EF", using video presentations and recycled-material play workshops. Parents reflected, discussed, and recorded their learning in the "EF Calendar," which served as both a reflective and behavioral tracking tool. Later sessions, "Sharing Experiences", "Creative Exchange", and "Reflect and Prepare" focused on peer interaction, experience-sharing via the LINE, symbolic learning stations, and group discussions; all of these activities reinforced practical EF strategies. The final activity, "Evaluating Outcomes," involved a role model sharing session and personal reflection through the activity "Stick & Think: EF Goals", emphasizing long-term application. These participatory activities empowered guardians to internalize EF concepts, shift attitudes, and adopt EF-supportive parenting behaviors, leading to measurable improvements in children's EF. The results align with previous studies, which also found that parent-involved learning programs significantly enhanced parenting behaviors and child development outcomes^{23,24}.

In the control group, no significant differences were observed in the mean scores of parental knowledge, attitudes, and behaviors regarding EF development in early childhood, nor in the EF development of children before and after the intervention. This may be explained by the fact that participants in the control group received only routine parenting information provided by local child development centers and public health service units during the study period. Although it is possible that some parents accessed additional information from external sources during the intervention period, such exposure was likely insufficient to promote meaningful changes in their understanding, attitudes, or caregiving behaviors. Consequently, the absence of a structured participatory learning program may have limited the control group's potential for change. These findings support

the study's hypothesis and underscore the importance of a comprehensive, experience-based intervention to enhance parenting competence and children's EF development.

Conclusion

This study confirms that a guardian participatory learning program, based on Kolb's Experiential Learning Theory, effectively enhances preschool children's EF by improving guardians' knowledge, attitudes, and behaviors. The experimental group showed significant improvements compared to the control group, highlighting the importance of active guardian involvement in early childhood brain development. While the results are encouraging, this study was not a clustered trial and relied on short-term, guardian-reported outcomes; therefore, the findings should be regarded as preliminary, and longer follow-up is warranted. Future research should assess long-term outcomes. The limitations of this study include constrained regional generalizability; findings should be extrapolated only to populations with socio-cultural characteristics similar to those in this study. We also acknowledge potential biases arising from participant selection and social desirability, which may have influenced guardian-reported outcomes. These points have been added to the manuscript for transparency. Additionally, we note the potential for national-scale integration by embedding structured, participatory caregiver sessions into routine services at child development centers and primary-care units, aligned with current child-development policy directions; future multi-centre studies with longer follow-ups are planned to confirm durability and inform scale-up.

Ethics approval

This study was approved by the Human Research Ethics Committee of the Chonburi Provincial Public Health Office (Approval No. CBO Rec 67-092; December 23, 2024). Informed consent from all participants was obtained

after explaining the study's objectives, procedures, and potential risks. All personal data were kept confidential, and results were reported in aggregate.

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Conflict of interest

The authors declare no conflicts of interest.

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Supplement data

Detailed description of the guardian participatory learning program

Facilitators, training, and supervision

The program was jointly implemented by the research team and child development center teachers.

All facilitators were trained following the program manual, which covered executive function (EF) concepts, participatory learning techniques, and fidelity monitoring procedures.

The research team conducted weekly supervision and review meetings to ensure consistency and quality control in program implementation across both centers according to the established standards.

Setting and delivery

The program was conducted onsite in small groups of 5–8 guardians at the child development centers.

Each weekly session took place in activity or meeting rooms that were suitable for interactive and experiential learning.

The LINE application was used as the main communication platform for continuous engagement, homework submission, and reflection throughout the program period.

Timing and dose

Duration and frequency

The program consisted of five consecutive weekly sessions held over a five-week period.

Each session lasted approximately 60 minutes, with a total contact time of around 300 minutes.

Session schedules were arranged according to the availability of guardians and the operational context of each center.

Weekly session descriptions

Session 1 – Understanding EF (60 minutes)

Objective: To build foundational knowledge about executive function (EF) and its critical role in early childhood development.

Activities: Concrete experience (10 min): watch an educational video on promoting EF in children and create simple toys using recycled materials.

Reflective observation (10 min): discuss and share parenting approaches in small groups.

Abstract conceptualization (10 min): Summarize key concepts through the “EF in Bloom” activity.

Active experimentation (15 min): Discuss ways to apply learned concepts in daily parenting practices and introduce the “EF Calendar” for home reflection and activity recording.

Session 2 – Sharing experiences (60 minutes)

Objective: To reflect upon and reinforce EF-supportive parenting behaviors.

Activities: concrete experience (10 min): guardians share successful experiences in promoting EF via the LINE group.

Reflective observation (15 min): discuss challenges and lessons learned from implementing EF strategies.

Abstract conceptualization (15 min): record reflections and photos in the EF Calendar.

Active experimentation (15 min): plan to apply the strategies learned in daily parenting routines.

Session 3 – Creative exchange (60 minutes)

Objective: To develop parenting skills and strategies that support EF through hands-on, experiential learning.

Activities: Concrete experience (25 min): participate in five learning stations representing the key EF dimensions: working memory, inhibition, cognitive flexibility, emotional regulation, and planning/organization.

Reflective observation (10 min): discuss insights and feelings after completing each station.

Abstract conceptualization (10 min): Summarize key ideas through the “EF Knowledge Pyramid” activity.

Active experimentation (10 min): Plan how to adapt and apply these strategies at home.

Session 4 – Reflect and prepare (60 minutes)

Objective: To review progress and prepare sustainable EF-promoting practices.

Activities: concrete experience (10 min): guardians share their real-life EF success stories through the LINE group.

Reflective observation (15 min): reflect on challenges faced and discuss possible improvements.

Abstract conceptualization (15 min): summarize key takeaways in the EF Calendar.

Active experimentation (15 min): Set personal goals for continuing EF-supportive parenting behaviors in daily life.

Session 5 – Empowering EF (60 minutes)

Objective: To consolidate learning outcomes and motivate guardians to sustain EF-supportive parenting behaviors.

Activities: Concrete experience (15 min): model guardians present their experiences and outcomes in promoting EF.

Reflective observation (15 min): review and discuss results using the EF Calendar.

Abstract conceptualization (15 min): summarize lessons learned through the “Stick Your Thoughts” activity.

Active experimentation (10 min): develop long-term goals and motivation plans to sustain EF-promoting practices at home.

Materials and tools

Program materials included short EF educational videos (2–3 minutes each), a parent handbook, weekly worksheets, and the EF Calendar for daily activity logging. Additionally, a LINE group usage guide was provided, featuring sample weekly reflection posts and photo formats to maintain consistency in participation and communication.

Homework and verification

Guardians were instructed to apply EF-promoting activities with their children at home at least three days per week. Each activity was recorded in the EF Calendar, and a brief reflection or photo was posted in the LINE group once per week. Facilitators reviewed submissions weekly, provided individual feedback, and followed up via phone calls or messages when submissions were missing.

Fidelity and dose monitoring

Program fidelity was evaluated using attendance logs, facilitator checklists, and weekly fidelity assessment forms. The average attendance rate exceeded 90%, and all participants completed all five sessions. For participants who missed a session, booster or make-up activities were provided via short review videos and summary worksheets through LINE. All make-up activities were documented and included in the fidelity tracking system.