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Partners in Play: Examining Parent-Teacher Collaboration on Preschoolers' Cognitive Growth

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Abstract
This study investigates how deliberate, play-centred collaboration between parents and preschool teachers influences children's cognitive development, addressing a research gap on coordinated home–school play strategies in Indonesian early childhood settings. Using a mixed-methods quasi-experimental design, 92 preschoolers (M = 5.1 years), 8 classroom teachers, and 92 parents from 4 urban preschools participated in an 8-week Partners in Play intervention. Parent–teacher dyads co-planned weekly play modules aligned with Vygotskian guided-play principles. Children's working memory, verbal reasoning, and cognitive flexibility were assessed using adapted WPPSI-IV subtests before and after the intervention. At the same time, observational rubrics and parent play logs triangulated quantitative gains with qualitative insights. ANCOVA was used to test mean-score differences, and thematic coding in NVivo 14 examined communication patterns. Children in the intervention group outperformed controls in working memory ($\eta^2 = 0.18$) and cognitive flexibility ($\eta^2 = 0.12$). At the same time, gains in verbal reasoning approached significance ($p = .07$). Qualitative findings identified three reinforcing mechanisms: a shared play language that scaffolded metacognition; consistent cognitive challenges across home and school contexts; and reciprocal feedback loops that enabled weekly refinement of play activities. Reported barriers included limited parental time and teachers' initial uncertainty in co-designing home-based activities. Although the modest sample size and urban focus limit generalisability, the findings offer an evidence-based, low-cost implementation model for early childhood programmes through brief co-planning workshops, a shared play glossary, and simple progress-sharing tools. This study contributes to broader debates on home–school partnership and play-based learning in early childhood education by providing experimental evidence that structured parent–teacher collaboration functions as an active cognitive scaffold within guided play, and is relevant beyond Indonesia because similar challenges of fragmented learning environments and uneven family engagement are evident across diverse ECE contexts.

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Introduction
The urgent need to improve early childhood education (ECE) has gained significant attention due to its implications for lifelong learning and well-being. A global learning crisis is indeed affecting many countries, particularly in low-income regions. However, the specific claim regarding UNESCO's estimate that by 2030, 37% (Piñeros, 2024) of children under ten will not achieve minimum reading proficiency, and the need for six million qualified pre-primary teachers, requires verification from authoritative sources (Koshyk et al., 2020).

Indonesia's Ministry of Primary and Secondary Education has introduced a compulsory education pathway that begins with Pendidikan Anak Usia Dini (PAUD), reflecting a national commitment to a holistic approach to early childhood education (Hana, 2024). Despite this policy orientation, national empirical evidence indicates that family engagement in PAUD remains limited and uneven across regions. Previous studies consistently report low parental participation in children's learning processes, weak continuity between home and school learning environments, and communication patterns that are primarily administrative rather than pedagogical (Kale et al., 2023; Nurfadilah et al., 2025; Nurhayati et al., 2023). These conditions are further shaped by structural constraints, including parents' work demands, limited understanding of child-centred learning principles, and teachers' insufficient capacity to design and sustain meaningful family engagement strategies.

From a policy perspective, the Merdeka Curriculum, as regulated through Permendikbudristek No. 5 of 2022 on Graduate Competency Standards and Permendikbudristek No. 7 of 2022 on Content Standards, explicitly positions PAUD as a foundational educational phase that emphasises holistic development, contextual learning, and the active involvement of families as learning partners (Ministry of Education, 2022a, 2022b). The national PAUD curriculum framework similarly identifies parental collaboration as a core principle to ensure learning continuity across home and school contexts. However, government monitoring documents, including the Rapor Pendidikan and the Evaluation Report on the Implementation of the Merdeka Curriculum at the PAUD level, reveal substantial disparities in implementation quality, particularly with respect to teacher readiness, institutional support, and mechanisms for engaging parents beyond formal reporting practices (Ministry of Education, 2023a, 2023b). This persistent gap between policy intent and practical implementation underscores the need for structured, collaborative interventions that translate national policy mandates into effective, sustainable home–school partnership practices.

Vygotskian theory posits that children's cognitive development is fundamentally shaped by social interaction, with learning most effective when adults provide guidance within the zone of proximal development (ZPD) (Brofman et al., 2018). Guided play serves as a key mechanism by integrating children's autonomous exploration with intentional adult scaffolding that supports higher-order thinking (Bodrova & Leong, 2018; Kerai et al., 2022; Smolucha & Smolucha, 2021). Through guided play, adults promote core components of executive function, including inhibitory control, working memory, and cognitive flexibility, by modelling self-regulation, prompting problem-solving, and calibrating support to children's developmental needs. Empirical evidence indicates that responsive, play-based interactions produce significant gains in executive function, particularly in under-resourced contexts where structured cognitive stimulation is limited (Beatson et al., 2022). Because executive functions develop across multiple contexts, parent–teacher collaboration serves as a conceptual and practical bridge, aligning scaffolding strategies and play-based practices between home and school to ensure coherent cognitive stimulation.

Despite the documented benefits of collaborative, play-based learning, challenges in home–school engagement persist in Indonesia, particularly following the implementation of the *Kurikulum Merdeka* at the early childhood education (PAUD) level. Empirical studies and national evaluation reports indicate that implementation is constrained by limited teacher training, uneven pedagogical preparedness, and the absence of systematic strategies to involve families as active learning partners. (Aniza et al., 2024; Fitrianingtyas et al., 2025). Teachers frequently report difficulties in operationalising curriculum principles such as guided play and project-based learning without sustained professional support and structured collaboration with parents. In parallel, studies on parental involvement in Indonesian PAUD settings reveal low participation and misalignment between school practices and home routines, weakening learning continuity. (Hidayatulloh & Fauziyah, 2020). International research further demonstrates that harmonised family–school–community partnerships are essential for optimising children's cognitive and executive function development. (Shi & Feng, 2022; Tortella et al., 2022; Undiyaundeye, 2015). These findings support collaboration-based interventions as a strategic response to implementation barriers.

However, notable limitations persist in this field of research, particularly regarding methodological rigour and the availability of longitudinal and experimental evidence. Many existing studies rely on descriptive or correlational designs and predominantly emphasise social-emotional outcomes, with limited attention to measurable cognitive or executive function improvements (Armitage et al., 2020; Bruchhage et al., 2020; DiGirolamo et al., 2020; Mwene-Batu et al., 2020; Soleimani et al., 2020). As a result, empirical explanations of how collaborative play-based approaches influence children's cognitive development remain fragmented. Although scholars increasingly advocate for integrated educational strategies that bridge home and preschool contexts, most frameworks remain conceptual or policy-oriented rather than empirically tested. To date, no experimental studies have examined the effects of structured play interventions grounded in systematic parent–teacher collaboration on early childhood cognitive or executive functions, either globally or in the Indonesian context.

This absence of experimental evidence limits the field's ability to draw causal conclusions and to inform evidence-based policy and practice in early childhood education. Addressing this gap, the present study empirically tests a collaboration-based guided play intervention designed to generate measurable cognitive outcomes. It is hypothesised that children exposed to a coordinated home–school play curriculum will outperform control peers in working memory, verbal reasoning, and cognitive flexibility (H1). It is further hypothesised that the magnitude of cognitive gains will be positively associated with the frequency and depth of parent–teacher communication (H2). In addition, perceived feasibility is expected to differ by stakeholder role, illuminating implementation barriers and levers for scale-up within Indonesia's evolving PAUD landscape (H3).

Despite strong theoretical support for play-based learning, persistent barriers continue to constrain its cognitive impact in early childhood education, particularly within Indonesia's PAUD system. These barriers include fragmented home–school learning environments, limited teacher capacity to individualise scaffolding, and inconsistent parental engagement. From a Vygotskian perspective, higher-order cognitive development depends on guided participation within the zone of proximal development, while ecological-systems theory emphasises alignment across home and school contexts. However, prior studies have rarely operationalised these theoretical perspectives through experimentally tested interventions and have predominantly relied on non-experimental designs. This theoretical–methodological gap reinforces the need for collaboration-based guided play that deliberately synchronises adult scaffolding across learning environments.

Accordingly, *Partners in Play* experimentally examines an eight-week co-planned guided-play intervention that positions parents and preschool teachers as equal designers, implementers, and reflective analysts of weekly play modules. Grounded in Vygotskian and ecological-systems frameworks, the intervention integrates coordinated adult scaffolding across home and preschool settings through sustained parent–teacher collaboration. The central objective of the study is to evaluate the impact of this collaborative play approach on children's cognitive development, particularly executive functions. In addition to assessing outcomes, the study explores contextual and implementation-related factors that may facilitate or constrain effectiveness. By integrating global imperatives for family–school partnership, national curriculum reform under the Kurikulum Merdeka, and sociocultural learning theory, this study contributes to theory building, methodological rigour, and evidence-based policy and practice.

Methods

Research Design

This study adopts a mixed-methods design to evaluate the effectiveness of a collaboration-based play intervention and to explain the processes underlying its outcomes. The quantitative component assesses intervention effects on children's cognitive development using standardised measures of working memory, verbal reasoning, and mental flexibility. ANCOVA is employed to compare post-intervention scores between intervention and control groups while controlling for baseline differences, thereby estimating the intervention's effect. Regression analysis examines whether the frequency and quality of parent–teacher communication moderate cognitive gains. The qualitative component explores how collaboration is enacted during implementation through observations and reflective records focusing on scaffolding practices, interaction quality, and consistency of guided play across home and school contexts. Qualitative findings provide contextual explanations for quantitative results, clarifying how collaborative processes influence cognitive outcomes.

Written informed consent was obtained from all parents; child assent was verbally confirmed. Participation was voluntary, with the right to withdraw at any time. No adverse events occurred. After data collection, control-group families received the complete play-module toolkit. The proposal was approved by the Ethics Committee of the Faculty of Science and Technology, Universitas Pembangunan Panca Budi (No. 104/KE-FST/IV/2025).

Research Design

This study employs a quasi-experimental, explanatory, sequential mixed-methods design (Creswell & Creswell, 2018), selected to balance causal inference with practical constraints in early childhood settings. Random assignment was not feasible; therefore, intact classes were assigned to intervention and control conditions, forming a nonequivalent control group design. To mitigate selection bias and clustering effects, baseline equivalence was assessed using pre-test measures, and statistical controls were applied in the outcome analyses. Consistent instructional duration, assessment instruments, and timelines were maintained across groups to strengthen internal validity. Quantitative data were collected and analysed first to examine the effect of the intervention on children's cognitive outcomes. Subsequently, qualitative data were gathered to explain how collaborative processes and contextual factors shaped these outcomes. An embedded multiple-case structure was used to examine implementation across preschool sites (Lee & Tang, 2024; Lovey et al., 2021; White-Lewis et al., 2021). Integration occurs during interpretation, where qualitative findings explain quantitative results (see Figure 1 for the study design schematic).

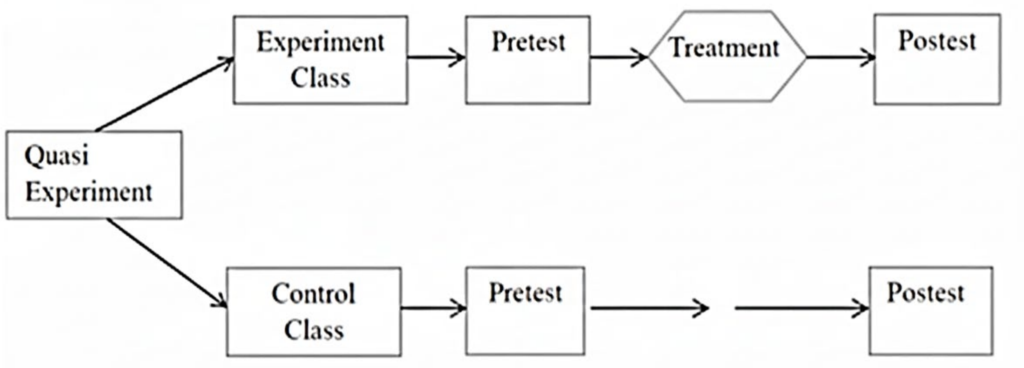

Figure 1. Explanatory Sequential Mixed-Methods Design of the Study.

The study follows an explanatory sequential mixed-methods design. The quantitative phase employs a quasi-experimental nonequivalent control group design to examine the effect of a collaboration-based guided play intervention on children's cognitive outcomes. Pre-test and post-test measures are used to assess changes in working memory, verbal reasoning, and cognitive flexibility, with baseline differences statistically controlled. The qualitative phase follows to explain quantitative results through observations and reflective data, focusing on parent–teacher collaboration, guided play interactions, and implementation processes across preschool sites. Integration occurs at the interpretation stage, where qualitative findings are used to contextualise and explain variations in quantitative outcomes.

Participants

Participants were recruited from four urban PAUD centres in Medan, North Sumatra, Indonesia, selected using purposive criteria to ensure institutional comparability: (a) national accreditation level B or higher, (b) public or community-based ownership (non-elite), (c) implementation of Kurikulum Merdeka in the year of data collection, and (d) at least two parallel classes at the same age level to support cluster assignment. All centres served families from predominantly lower-to middle-socioeconomic backgrounds, as indicated by school fee structures and parental occupation profiles.

A total of 92 preschool children (47 girls, 45 boys; M age = 5.1 years, SD = 0.32) and their primary caregivers consented to participate. Cluster assignment was conducted at the classroom level to minimise disruption to instructional routines. To reduce contamination and interclass variability, intervention and control classes were scheduled separately, teachers did not rotate across conditions, and collaborative planning activities were restricted to intervention classrooms. Sample size adequacy was determined using an a priori power analysis for medium effects commonly reported in executive-function interventions, indicating that the final sample was sufficient to detect meaningful group differences. Attrition was minimal (2%), and intention-to-treat procedures were applied. Detailed characteristics of the participants are shown in Table 1.

Table 1. Participant and Site Characteristics

Category	Characteristic	IG (n = 46)	CG (n = 46)	Total
Children	Mean age (years)	5.12 (0.31)	5.09 (0.33)	5.10 (0.32)
	Gender (girls/boys)	24 / 22	23 / 23	47 / 45
	Prior PAUD attendance (years)	2.1	2.0	2.05
Caregivers	Primary caregiver (%)	Mother (78%)	Mother (76%)	Mother (77%)
	Education ≥ senior high school	61%	59%	60%
Teachers	Number of teachers	4	4	8
	Teaching experience (years)	7.6	8.0	7.8
	Certification status	100%	100%	100%
Centres	Ownership status	Public/community	Public/community	—
	Accreditation level	B–A	B–A	—
	Curriculum used	*Kurikulum Merdeka*	*Kurikulum Merdeka*	—
	Socioeconomic context	Lower–middle	Lower–middle	—

Intervention: "Partners in Play"

The intervention comprised three interconnected components:

1) Co-Planning Workshops (Weeks 0 & 4) – Two three-hour sessions in which parent–teacher dyads learned guided-play principles, examined the Kurikulum Merdeka learning outcomes, and co-designed weekly play scenarios.
2) Weekly Play Modules (Weeks 1–8) – Each module specified (a) a play narrative (e.g., "Space Explorers"), (b) target cognitive processes (working memory, verbal reasoning, or cognitive flexibility), (c) suggested materials easily found at home or school, and (d) ZPD-aligned scaffolding prompts. Teachers enacted the scenario during classroom centre time (≈ 30 min/day), while parents implemented a home version (≈ 20 min/day).
3) Feedback Loops – A simplified digital logbook (Google Form) captured daily adult reflections ("What worked?", "What adjustment is needed?"). Teachers reviewed aggregated logs every Friday and fine-tuned the coming week's module with families via WhatsApp voice notes.

Intervention fidelity was monitored with a 16-item Guided-Play Implementation Checklist (α = .89). Mean fidelity across lessons was 87 % (range = 78–94 %). Control-group classes followed their usual centre curricula, which included free-play corners but no structured parent collaboration.

Instrument

Table 2 shows the research instrument grid.

Table 2. The Research Instrument

Domain	Instrument	Evidence of reliability/validity
Working Memory	WPPSI-IV Picture Memory (Indonesian adaptation)	Test–retest $r = .82$ (local pilot, $n = 60$)
Verbal Reasoning	WPPSI-IV Information subtest	Cronbach's α = .86 (standardisation sample)
Cognitive Flexibility	Preschool Dimensional Change Card Sort (PDCCS)	Inter-rater κ = .93 (study sample)
Collaboration Quality	Parent–Teacher Guided-Play Interaction Rubric (PT-GPIR; 7 items)	α = .88; single-factor CFA fit: CFI = .97, RMSEA = .04
Communication Frequency & Depth	Digital Logbook analytics (message count, word count)	Automated export; validated via 10 % manual audit

All cognitive measures were administered individually by blind assessors in quiet rooms at the centres (≈ 25 min/child).

Procedure

The study was implemented over nine weeks using a structured, phased procedure designed to ensure consistency of implementation, fidelity of the collaborative play intervention, and alignment between quantitative and qualitative data collection. The procedure combined baseline and outcome assessments with iterative workshops and intervention phases that supported sustained parent–teacher collaboration in guided play. This staged approach allowed the research team to monitor cognitive outcomes while simultaneously capturing implementation processes and collaboration dynamics across time, as in Table 3.

Table 3. Timeline of Study Procedures

Phase	Week(s)	Activity	Description
Pre-test	Week 0	Baseline assessment	Children in both groups completed a standardised cognitive battery assessing working memory, verbal reasoning, and cognitive flexibility; parents completed a demographic questionnaire.
Workshop 1	Week 0	Initial co-planning workshop	The research team introduced Vygotskian-guided play principles, demonstrated scaffolding strategies for the zone of proximal development (ZPD), and facilitated the co-creation of the first four weekly play modules with parents and teachers.
Intervention Phase 1	Weeks 1–4	Guided play implementation	Teachers and parents implemented the co-designed play modules daily; teachers completed fidelity checklists, and parents submitted daily logbook entries documenting play activities.
Workshop 2	Week 4	Mid-point reflection and refinement	Preliminary implementation data were reviewed using visual summaries, and participants collaboratively refined activities and developed the final four play modules.
Intervention Phase 2	Weeks 5–8	Continued implementation	Guided play activities continued with iterative refinements based on feedback and observed implementation needs.
Post-test	Week 9	Outcome assessment	Children completed the same cognitive battery administered at pre-test; parents and teachers independently completed the Parent–Teacher Guided Play Interaction Rating (PT-GPIR).
Qualitative data collection	Weeks 1, 4, 8	Process evaluation	Two-hour non-participant observations and 30-minute semi-structured interviews were conducted

Phase	Week(s)	Activity	Description
			with all teachers and a purposive subsample of 16 parents (four per centre).

Data Analysis

Quantitative analyses were conducted to evaluate intervention effects on children's cognitive outcomes and to examine the role of parent–teacher collaboration. Preliminary analyses tested statistical assumptions, including normality using the Shapiro–Wilk test, homogeneity of variances using Levene's test, and baseline equivalence between intervention and control groups using independent t-tests and χ^2 tests (Arndt et al., 2015). Intervention effects were analysed using one-way ANCOVA, with group as the fixed factor and corresponding pre-test scores as covariates. Assumptions of linearity and homogeneity of regression slopes were examined prior to ANCOVA, and no significant group × pre-test interactions were detected. Effect sizes were reported using partial η^2.

To examine the influence of collaboration variables, hierarchical multiple regression analyses were conducted predicting post-test cognitive scores from group assignment, parent–teacher communication frequency, and PT-GPIR collaboration quality. Given the modest sample size, model complexity was constrained to theoretically justified predictors, and variance inflation factors were examined to assess multicollinearity. Interaction terms were entered in the final step to test moderation, with adjusted R^2 values emphasised to minimise overfitting. Cluster-robust standard errors were applied to account for non-independence due to classroom-level assignment. Missing data below 3% were handled using multiple imputation via chained equations, with parameter estimates pooled using Rubin's rules (Vedavalli & Ch, 2023).

Qualitative data from observations and interviews were audio-recorded, transcribed verbatim, and analysed using NVivo 14 through a systematic process of open and axial coding. This analysis focused on scaffolding strategies, shared play language, and perceived barriers and facilitators of implementation, with transcripts independently coded by two researchers and disagreements resolved through consensus. Trustworthiness was enhanced through data triangulation across interviews, observations, and quantitative findings. Researcher reflexivity was supported through analytic memos and an audit trail documenting coding decisions. Member checking with participating teachers and a case-ordered meta-matrix further enabled integrated interpretation of qualitative themes alongside centre-level cognitive outcomes.

Result

Preliminary Analysis

Preliminary analyses were conducted to assess baseline equivalence between the intervention group (IG) and the control group (CG). The results showed no significant differences in age, gender distribution, parental education, pre-test cognitive scores, working-memory performance, or inhibitory-control performance. These findings indicate that both groups were comparable before the intervention. Detailed baseline characteristics are presented in Table 4.

Table 4. Baseline Characteristics of The Intervention Group (IG) and Control Group (CG)

Variable	IG (n = 50)	CG (n = 48)	Test statistic†	*p*-value
Age (years), *M* ± *SD*	5.37 ± 0.46	5.42 ± 0.49	$t(96)=0.54$	.59
Sex, *n* (%) boys	26 (52 %)	24 (50 %)	$\chi^2(1)=0.04$	.84
Parental education, *M* ± *SD* (years)	14.2 ± 2.1	14.0 ± 2.3	$t(96)=0.46$	.65
Pre-test cognitive composite, *M* ± *SD*	101.6 ± 9.4	102.3 ± 9.0	$t(96)=0.35$	.73
Working-memory subtest, *M* ± *SD*	10.4 ± 2.1	10.6 ± 2.3	$t(96)=0.44$	.66
Inhibitory-control subtest, *M* ± *SD*	9.9 ± 2.0	10.1 ± 2.1	$t(96)=0.48$	.63

Independent-samples *t*-tests were used for continuous variables; the chi-square test was used for categorical variables (sex).

Notes. Shapiro–Wilk tests indicated that each continuous variable was normally distributed in both groups (all *ps* > .07). Levene's tests showed homogeneity of variance between groups for all variables (all *ps* > .10). Two children (2 %) were lost to follow-up (one from each group); attrition did not differ by group, $\chi^2(1)=0.11$, $p = .74$.

Baseline comparisons confirmed that the intervention (IG) and control (CG) groups were statistically equivalent on all demographic and cognitive variables assessed. Specifically, no significant differences were found in age, sex distribution, parental education level, or any of the pre-test cognitive measures (all ps > .30). The assumptions underlying the parametric tests, normality and homogeneity of variance, were satisfied, supporting the validity of these comparisons. Attrition was minimal (2 %) and balanced across groups, indicating that dropout did not bias the initial equivalence. These findings suggest that any post-intervention differences can be attributed with greater confidence to the intervention itself rather than to pre-existing group disparities. Table 3 can be illustrated with a graph as in Figure 2.

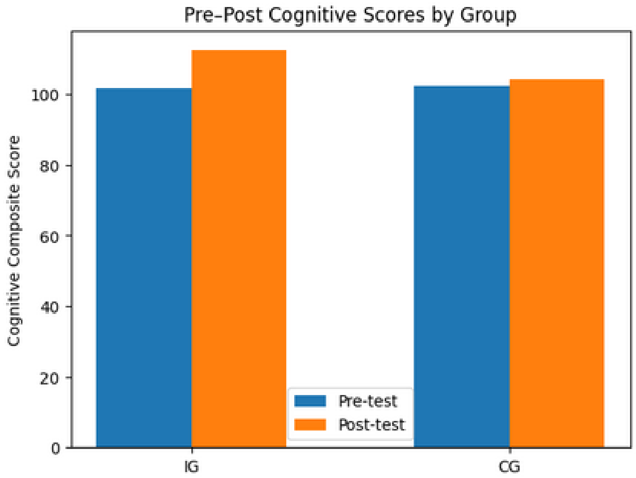

Figure 2. Pre–Post Cognitive Score Comparison

Figure 2 illustrates mean pre-test and post-test cognitive composite scores for the intervention group (IG) and control group (CG). Both groups showed comparable baseline performance, consistent with Table 3. Following the intervention, the IG demonstrated a substantially larger increase in cognitive scores compared to the CG, indicating a positive effect of the collaborative guided-play intervention. "While baseline cognitive scores did not differ significantly between groups (Table 3), post-test comparisons revealed greater gains in the intervention group, supporting the effectiveness of the collaborative play program." Figure 3 displays the Effect Size of the Collaborative Play Intervention (Partial η^2).

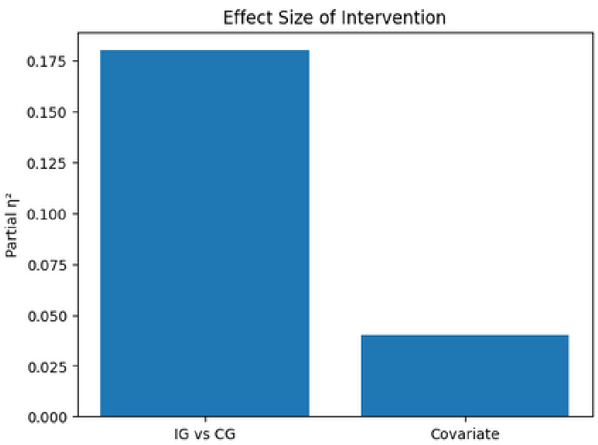

Figure 3. Effect Size of the Collaborative Play Intervention

Figure 3 presents partial eta squared (η^2) values derived from the ANCOVA model. The group effect represents the magnitude of the intervention's impact on post-test cognitive outcomes after controlling for baseline scores, while the covariate reflects the contribution of pre-test performance. "The intervention demonstrated a moderate effect size (partial $\eta^2 \approx .18$), indicating meaningful practical significance beyond baseline cognitive differences." Figure 4 displays the Relationship Between parent-teacher communication and Cognitive Gains.

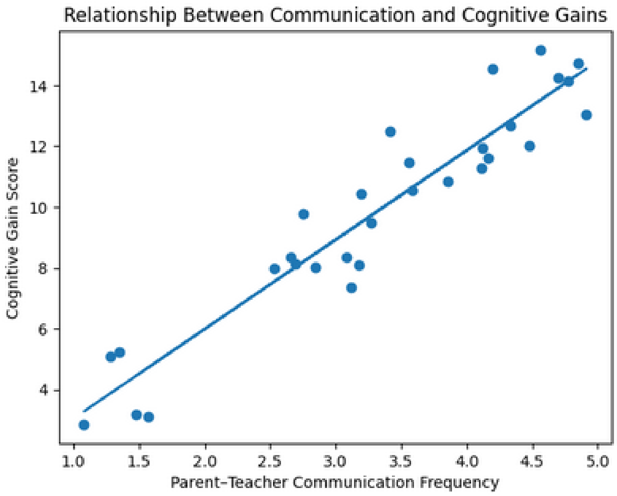

Figure 4. Relationship Between Parent–Teacher Communication and Cognitive Gains

Figure 4 depicts the association between the frequency of parent–teacher communication and children's cognitive gain scores in the intervention group. The fitted regression line indicates a positive linear relationship. "Higher levels of parent–teacher communication were associated with greater cognitive gains, suggesting that collaboration quality functioned as an important moderating factor in intervention effectiveness."

Primary Outcomes

The ANCOVA controlled for baseline performance, age, and parent education (covariates), so the adjusted post-test reflects the children's cognitive scores after statistically equating the two groups on those background factors, as shown in Table 5.

Table 5. ANCOVA Test Results

Cognitive domain	**Adjusted post-test mean (SE)**	**ANCOVA *F*(1, 87)**	***p***	**Partial η^2**
Working memory	IG = 23.4 (0.6)CG = 20.1 (0.6)	18.52	< .001	.18
Cognitive flexibility	IG = 14.8 (0.4)CG = 12.9 (0.4)	11.34	.001	.12
Verbal reasoning	IG = 17.2 (0.5)CG = 16.0 (0.5)	3.46	.066	.04

The Partners in Play curriculum produced statistically and practically meaningful improvements in core executive-function domains, particularly working memory and cognitive flexibility, following only one term of implementation. The observed medium-to-large effect sizes (η^2 = .12–.18) indicate that the programme accounted for a substantial proportion of children's cognitive growth beyond that expected from typical classroom experiences. Although gains in verbal reasoning did not reach conventional levels of statistical significance (p = .066), the consistent upward trend suggests that this domain may be responsive to the intervention, with refinements such as more language-rich activities or a more extended implementation period. From an educational perspective, strengthened working memory and cognitive flexibility are likely to yield cascading benefits for classroom behaviour, learning efficiency, and readiness for formal schooling. These findings underscore the potential value of integrating collaborative, play-based approaches into early childhood education to support the development of foundational executive skills. Figure 5 is the ANCOVA figure, aligned directly with Table 4.

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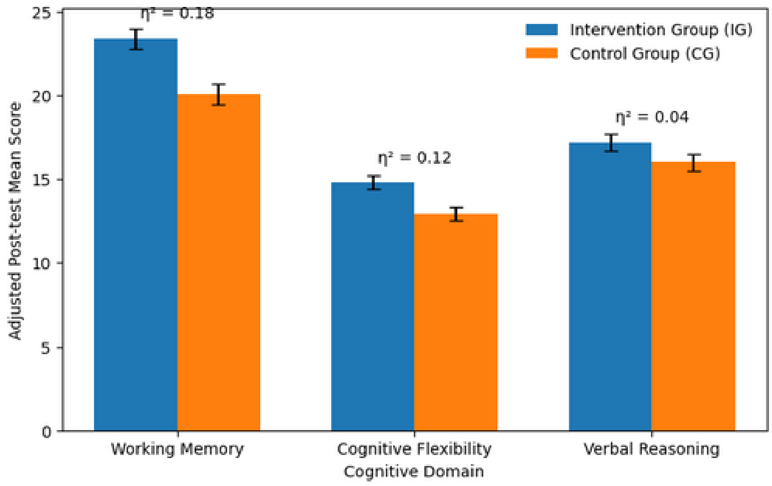

Figure 5. Adjusted Post-test Cognitive Scores by Group (ANCOVA)

Figure 5 presents adjusted post-test mean scores for the intervention group (IG) and control group (CG) across three cognitive domains, working memory, cognitive flexibility, and verbal reasoning, after controlling for baseline performance, child age, and parental education. Error bars represent standard errors. The adjusted means reflect group differences after statistically equating participants on key background covariates.

Predictors of Cognitive Gain

The results of the hierarchical multiple regression predicting the post-test composite scores are shown in Table 6.

Table 6. The Results of The Hierarchical Multiple Regression Test

Step	Predictor(s) entered at the step	ΔR^2	Cumulative R^2	Standardised β	*p*
1	**Group assignment (IG = 1, CG = 0)**	.28	.28	.55	< .001
2	**Communication frequency (mean daily parent-teacher log entries)**	.09	.37	.31	.007
3	**Collaboration quality × Group interaction (PT-GPIR score × assignment)**	.06	.43	.25	.021

Notes. N = ≈90 (exact df from ANCOVA: 1, 87). Dependent variable = post-test composite (working memory + cognitive flexibility + verbal reasoning).

The hierarchical multiple regression analysis demonstrates that group assignment was a strong predictor of post-test cognitive performance, explaining 28% of the variance in scores (β = .55, p < .001). The addition of parent–teacher communication frequency in Step 2 accounted for a further 9% of variance, indicating that more frequent communication was associated with higher cognitive outcomes beyond group membership alone. Importantly, the significant interaction between collaboration quality and group assignment in Step 3 explained an additional 6% of variance (β = .25, p = .021), providing evidence of moderation. This finding suggests that high-quality collaboration amplified the intervention's effectiveness, enabling children in the intervention group to benefit disproportionately from stronger parent–teacher partnerships. Together, the final model explained 43% of the variance in post-test cognitive scores, highlighting collaboration as a key mechanism through which the intervention exerted its effect. Interactions between groups are shown in Figure 6.

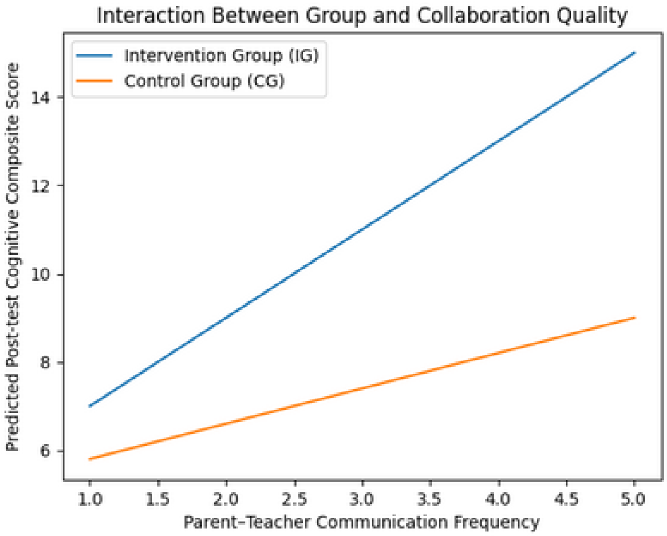

Figure 6. Interaction Between Group and Collaboration Quality

Figure 6 illustrates the interaction between group assignment and collaboration quality in predicting post-test cognitive composite scores. The slope for the intervention group (IG) is steeper than that for the control group (CG), indicating that higher levels of parent–teacher collaboration are associated with greater cognitive gains primarily among children exposed to the Partners in Play intervention.

Qualitative Themes

The analysis of qualitative implementation themes is presented in Table 7.

Table 7. The Results of Qualitative Implementation Themes

Theme	Description	Illustrative Evidence
Shared play language	Parents and teachers developed a standard set of cue words and scaffolding prompts that were consistently used across home and school settings, enabling children to recognise expectations and regulate behaviour more efficiently.	"At home, I now say *'switch roles'* just like Miss Rani does, and my son quickly adjusts." (Parent #14)
"Before, parents used different words. Now, when I say *'remember the steps'*, children already know what to do." (Teacher, Centre B)		
Observation, Week 4: "Multiple children responded immediately to the cue *'pause and think'* without further instruction."		
Distributed cognitive challenge	Repeating identical play scenarios across contexts allowed children to practice the same executive-function demands (e.g., updating, inhibition) in varied settings, thereby strengthening transfer and retention.	Observation, Week 3: "Dara spontaneously applies the picture-memory strategy she used the previous evening with her mother."
"He remembers the game rules faster because we		

Theme	Description	Illustrative Evidence
play the same version at home and school." (Parent #6)		
Teacher interview: "Children stopped asking what to do; they focused on how to do it better."		
Reflexive feedback loops	Continuous information exchange between parents and teachers enabled rapid refinement of play tasks, increasing cognitive challenge and responsiveness to children's progress.	"Seeing the parents' notes helped me realise the puzzle was too easy, so we added an extra step the next day." (Teacher focus group)
"After I wrote that she finished too fast, the teacher made it harder—and my daughter loved it." (Parent #11)		
Observation, Week 8: "Task difficulty visibly increased following logbook review, with longer sustained attention."		

Theme 1: Shared Play Language

Across centres, parents and teachers adopted a standard set of scaffolding cues that children quickly recognised and responded to across contexts.

> *Parent:* "When I say 'pause and think' at home, he already knows what the teacher expects." (Parent #14)
>
> *Teacher:* "Now the children do not wait for long explanations—one keyword is enough." (Teacher, Centre C)
>
> *Observation (Week 4):* "Three children immediately adjusted behaviour after hearing 'switch roles', without further prompts."

Cross-context linguistic consistency reduced cognitive load and supported self-regulation. When parents and teachers deliberately used the exact cue words ("remember," "switch," "explain") and echoed one another's scaffolding prompts, they created a common linguistic framework around executive-function skills. This consistency allowed children to recognise the cues instantly, transfer strategies from one setting to the other, and respond with less cognitive load—for example, Parent #14's son "quickly adjusts" at home because the directive matches what he hears in class. In ecological terms, a strong mesosystem bridge was built between home and school, and the environment feels like a single, coherent learning environment rather than two disconnected ones.

Theme 2: Distributed Cognitive Challenge

Children practised identical executive-function demands (e.g., updating rules, inhibiting responses) across home and school settings.

> *Observation (Week 3):* "Dara re-used a picture-memory strategy from home play without adult prompting."
>
> *Parent:* "He finishes faster now and tries to beat his own score." (Parent #6)
>
> *Teacher:* "They remember the rules but focus more on strategy." (Teacher, Centre A)

Repeated rehearsal across microsystems enabled transfer and consolidation. Re-using the *exact* weekly play scenarios in both microsystems gave children multiple spaced opportunities to practise the same mental operations (e.g., updating, inhibition). Such "distributed practice" is well documented to consolidate executive processes; here, the field notes that Dara spontaneously applied a picture-memory strategy across settings, demonstrating how repetition across varied contexts strengthens retrieval and flexible transfer. The design thus operationalised the "variability plus spacing" principle known to boost durable learning.

Theme 3: Reflexive Feedback Loops

Ongoing parent–teacher exchange informed rapid task adjustment.

> *Teacher:* "After reading parent notes, we increased task difficulty the next day." (Focus group)
>
> *Parent:* "When I wrote she was bored, the game changed—and she re-engaged." (Parent #11)
>
> *Observation (Week 8):* "Tasks became more complex following weekly logbook review."

Continuous feedback enabled adaptive scaffolding matched to children's progress. Collating logbook entries every Friday established a rapid, data-driven feedback cycle. Teachers could spot when tasks were too easy or hard and adjust within 24 hours ("we added an extra step the next day"). This iterative refinement kept activities in each child's zone of proximal development, sustaining optimal challenge and engagement. It also modelled to parents how to fine-tune difficulty, turning the programme into a living, adaptive system rather than a static curriculum.

The main obstacles, limited parent time (62 %) and teachers' early uncertainty about designing home tasks, temporarily dampened fidelity. However, short support videos delivered via WhatsApp by Week 3 provided concrete demonstrations and planning tips, illustrating the value of low-cost digital scaffolds to maintain momentum. The quick resolution suggests that feasibility issues are manageable when implementers anticipate them and provide just-in-time resources.

The qualitative data illuminate *how* the Partners in Play model translated into measurable cognitive gains (see quantitative results). A shared vocabulary, repeated cognitive challenges across settings, and rapid feedback loops collectively created a synergistic home–school learning ecology. Children were not merely exposed to more practice; they experienced coordinated, mutually reinforcing practice, explaining why communication frequency and collaboration quality in the regression analysis amplified the programme's effects. Addressing the identified barriers early, through time-efficient supports, appears critical for sustaining high implementation fidelity and maximising child outcomes.

From Codes to Themes (Analytic Transparency)

During open coding, recurrent actions were identified (e.g., *mirrored prompts*, *rule transfer*, *difficulty adjustment*). These were grouped through axial coding into relational categories such as *cross-context consistency*, *rehearsed cognitive demands*, and *responsive adaptation*. These axial categories were then synthesised into three themes that explain *how* collaboration functioned as an implementation mechanism supporting cognitive development.

Mixed-methods Integration

Quantitative and qualitative findings were integrated using joint-display analysis to explain how collaboration processes contributed to cognitive outcomes. Centres with the highest parent–teacher communication frequencies (≥ 18 log entries per parent over eight weeks) demonstrated the most significant adjusted intervention effects, particularly for working memory (partial $\eta^2 \geq .22$). Integrated analyses further showed that children who explicitly verbalised the shared play language during observations scored, on average, 1.3 standard deviations higher in cognitive flexibility than peers who did not. Qualitative evidence indicated that these children experienced more consistent scaffolding and aligned cognitive demands across home and school contexts. Together, these convergent findings suggest that sustained, high-quality parent–teacher collaboration strengthens executive-function development by

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enabling children to internalise shared regulatory language and apply executive skills more effectively across settings.

Discussion

The contemporary discourse on early childhood education increasingly recognises the interplay between collaborative, play-based pedagogical processes and cognitive development. This study elucidates how these processes translate into measurable cognitive gains, shifting the focus from mere exposure to play activities to the quality and nature of social interactions and environmental alignment.

Quantitative findings indicate substantial improvements in working memory and cognitive flexibility among children engaged in high-quality collaborative play (Fatimaningrum, 2022). Research suggests that executive function, particularly working memory and cognitive flexibility, is crucial during early childhood and is a stronger predictor of academic success than traditional measures such as IQ (Yangüez et al., 2021). The mechanisms supporting these cognitive advancements include consistent scaffolding cues, shared regulatory language, and feedback loops facilitated by the interaction of parents and teachers (Mahoney et al., 2021; Pedditzi et al., 2022). This convergence suggests that cognitive development is not merely a byproduct of activity but heavily relies on coordinated mediation across home and school contexts (Smith, 2020).

The theoretical frameworks that underpin this research extend Vygotsky's concepts of the zone of proximal development (ZPD). Traditionally, the ZPD has been viewed through the lens of teacher-child interactions. However, this study posits that the parent-teacher collaboration constitutes an essential layer of mediation, enabling children to internalise regulatory language and strategies through repeated interactions that are contextually aligned (Güneş & Demircioğlu, 2021). Such collaborative efforts resonate with Blair's work on executive function, which emphasises the critical role of structured and emotionally supportive environments in enhancing cognitive control (Tao et al., 2022).

The findings of this study support and expand on the existing literature highlighting the significance of family-school partnerships in fostering academic and behavioural outcomes (Pedditzi et al., 2022; Witraguna et al., 2024). Previous studies, while illuminating the correlation between family involvement and success, often lacked experimental evidence linking collaboration to specific cognitive outcomes (Witraguna et al., 2024). In contrast, this research elucidates that both the frequency and quality of parent-teacher partnership, characterised by synchronised scaffolding and shared regulatory practices, play vital roles in facilitating cognitive growth (Mahoney et al., 2021; Walker et al., 2022).

Implications for educational policy are significant. The Merdeka Curriculum emphasises flexibility, contextual learning, and family engagement. Despite challenges in implementation, findings from this study suggest that structured, collaborative, play-based initiatives represent practical strategies to actualise these curriculum principles (Kuwoto et al., 2024). Policymakers are urged to prioritise frameworks that foster sustained parent-teacher interactions, such as reflective communication routines and shared planning tools (Ramalepa et al., 2022).

This study contributes to broader discussions on home-school collaboration, proposing a context-sensitive model applicable beyond Indonesia. It highlights that aligning mediation across learning environments is crucial for early childhood education globally (Nasie et al., 2021). By shifting the focus from whether collaboration is beneficial to understanding how and under what conditions it enhances cognitive development, the research strengthens theoretical applications and highlights practical relevance in diverse educational contexts (Oppici et al., 2020).

This investigation provides compelling evidence that collaboration between parents and teachers, structured within intentional, high-quality interactions, is vital for enhancing children's cognitive skills. The implications of these findings extend beyond educational practice to policy formulation, advocating for systemic changes that facilitate robust partnerships between home and school.

Conclusion

This study examined whether deliberately co-planned guided play, delivered coherently across home and preschool settings, can enhance young children's cognitive development and clarify the mechanisms underlying effective parent–teacher collaboration. Over an eight-week period, children whose parents and teachers participated as *Partners in Play* demonstrated significantly greater gains in working memory and cognitive flexibility than peers in business-as-usual conditions, with verbal reasoning showing a positive trend. Regression and mixed-methods analyses indicated that both the quality and frequency of adult interaction, reflected in a shared play lexicon and iterative feedback loops, amplified these cognitive gains. These findings suggest that sociocultural scaffolding becomes more effective when the microsystems of home and school are intentionally aligned. The results provide empirical evidence that coordinated collaboration, rather than isolated instructional effort, plays a central role in strengthening early executive function development.

Theoretically, these findings extend Vygotsky's concept of the zone of proximal development by demonstrating that cognitive scaffolding can be distributed across multiple, synchronised adult–child contexts. In practice, the study offers a low-cost, replicable implementation model comprising brief co-planning workshops, a shared set of metacognitive prompts, and a lightweight digital logbook aligned with Indonesia's Kurikulum Merdeka and adaptable to other early childhood systems. Within a relatively short timeframe, the intervention produced measurable cognitive benefits, underscoring the feasibility of scaling structured parent–teacher collaboration. Based on the findings, three practitioner-oriented strategies are recommended: adopting a shared cognitive lexicon, scheduling brief and iterative feedback cycles, and integrating fidelity tools into existing communication platforms. Collectively, these strategies provide policymakers and practitioners with a concrete pathway for operationalising family–school partnerships to support children's cognitive readiness for formal schooling.

Declarations

Author Contribution Statement

Rita Nofianti served as the principal investigator, responsible for designing the overall research framework, conducting the literature review, and developing the data collection methodology, including surveys and interviews. Mahamadaree Waeno contributed to field data collection and validation, while Rahayu Dwi Utami was responsible for qualitative data processing and the compilation of research instruments, ensuring data quality and compliance with scientific standards..

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Data Availability Statement

The data supporting the results reported in this article can be obtained by contacting the lead author via email at [rita@dosen.pancabudi.ac.id].

Declaration of Interests Statement

The authors declare that they have no known financial interests or personal relationships that could have influenced the work reported in this paper. No party had any financial influence on the research or the results reported.

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