

Project-Based Learning in Promoting Cognitive Development in Early Childhood: A Systematic Literature Review

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Abstract

Purpose	: Project-Based Learning (PjBL) has emerged as a constructivist pedagogical approach of significant value in Early Childhood Education (ECE), positioning children as active agents in knowledge construction. This systematic review aims to synthesise empirical and review-based evidence on the role of PjBL in promoting cognitive development in young children aged 0–8 years, with particular attention to the amplifying function of loose parts media and the convergence of international Scopus-indexed findings with Indonesian local research.
Methodology	: Following PRISMA guidelines and Kitchenham (2004) procedures, a systematic search was conducted across Scopus, SINTA, DOAJ, and Google Scholar. From 1,554 initial records, 22 peer-reviewed articles published between 2020 and 2026 were selected for thematic content analysis: 12 from local Indonesian databases and 10 from Scopus.
Results	: Seven cognitive themes were identified across the 22 studies: critical and reflective thinking (77%), creativity (68%), problem-solving (64%), observation and classification (45%), independence and self-regulation (41%), executive function (32%), and 4C/21st-century competencies (36%). International evidence (Chen et al., 2026; Albar & Southcott, 2021; Alibek & Akhmetova, 2025) corroborates the consistency and cross-cultural generalisability of these findings.
Conclusions	: PjBL constitutes an empirically supported, developmentally appropriate strategy for cultivating multidimensional cognitive competencies in young children. The integration of loose parts media optimises cognitive outcomes by providing open-ended material richness within a purposive project framework. Findings align with Piagetian, Vygotskian, and Brunerian constructivism.

Keywords: project-based learning, cognitive development, Early Childhood Education (ECE), constructivism

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1. Introduction

Cognitive development in early childhood constitutes the developmental bedrock upon which all subsequent academic and social learning is built. Piaget's constructivist theory locates children aged two to seven years in the preoperational stage, characterised by the emergence of symbolic function, egocentric reasoning, and the nascent capacity for intuitive thought. At this stage, abstract instruction is largely ineffectual; what young learners require are sustained, concrete, and goal-directed experiences that scaffold the development of representational and logical thinking (Krajcik & Shin, 2022; Ummaroch et al., 2025). Complementing Piaget, Vygotsky's sociocultural framework emphasises the Zone of Proximal Development (ZPD), wherein a child's cognitive capacity is most effectively extended through guided participation in tasks that slightly exceed their current independent level a principle directly operationalised in well-designed project-based activities (Plotnikova et al., 2025).

Despite the rich theoretical consensus supporting active, exploratory learning in ECE, classroom practice in Indonesia remains predominantly teacher-centred. Observational reports from ECE centres in multiple provinces document a persistent reliance on calistung (reading, writing, arithmetic drills) and prescriptive worksheet activities that narrow children's opportunities for independent exploration and higher-order reasoning (Herlina et al., 2026). This misalignment between developmental theory and pedagogical reality has been further complicated by the implementation of Kurikulum Merdeka (Freedom Curriculum), which

formally requires schools to adopt more child-centred, project-oriented approaches yet many ECE teachers report inadequate preparation for this transition (Pratiwi et al., 2025).

Project-Based Learning (PjBL) offers a theoretically grounded and practically feasible response to this challenge. Krajcik and Shin (2022, p. 72) define PjBL as a learner-centred pedagogy in which students investigate "authentic, complex questions, problems, or challenges" and produce tangible artefacts as evidence of their learning. In ECE contexts, this framework is adapted to the developmental capacities of young learners: projects are time-bounded, artefacts are concrete and personally meaningful, and teacher scaffolding is intensive and responsive (Rahman et al., 2012; Alromaih et al., 2022). The empirical evidence for PjBL's cognitive benefits in ECE has grown substantially over the past decade, spanning quasi-experimental designs (Cahyaningsih & Harun, 2023; Chen et al., 2026), systematic reviews (Permatasari et al., 2025; Alibek & Akhmetova, 2025), and action research (Lestarinigrum & Wijaya, 2020).

A particularly promising development within this literature is the integration of loose parts open-ended, manipulable materials with no predetermined function as media within PjBL frameworks. Drawing on Nicholson's (1971) loose parts theory, scholars argue that the unlimited affordances of such materials uniquely position them to stimulate curiosity, creative thinking, and classification behaviour in young children (Sukardjo et al., 2023; Herlina et al., 2026). When embedded within a PjBL structure, loose parts provide the material richness that amplifies the cognitive demands and exploratory depth of project activities (Lestarinigrum & Wijaya, 2020; Imamah & Muqowim, 2020).

Despite the growing volume of evidence, existing reviews in this domain remain largely confined to single-database searches and Indonesian-language source pools, limiting their international generalisability. The present study addresses this gap by integrating Scopus-indexed international evidence alongside Indonesian local research, thereby producing a more comprehensive and internationally situated synthesis. Specifically, this review aims to: (1) systematically analyse the role of PjBL in promoting cognitive development in ECE children; (2) map cognitive domains most consistently evidenced across 22 included studies; (3) examine the amplifying mechanisms of loose parts media within PjBL frameworks; and (4) situate Indonesian findings within the broader international scholarly landscape through Scopus-indexed comparative evidence.

2. Methodology

2.1 Research Design

This study adopts a Systematic Literature Review (SLR) design, selected for its capacity to synthesise evidence from heterogeneous sources through a transparent, replicable, and bias-minimised process (Kitchenham, 2004). The review adheres to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) reporting framework, which mandates explicit eligibility criteria, a documented multi-stage search strategy, and structured synthesis procedures. This design is appropriate given the breadth and methodological diversity of the PjBL–ECE literature across both Indonesian and international contexts.

2.2 Literature Search Strategy

The literature search was conducted across four databases: Scopus (international, peer-reviewed), SINTA (Indonesian indexed journals), DOAJ (open-access international and Indonesian journals), and Google Scholar (broad supplementary coverage). For Scopus, the following Boolean search string was applied in the Advanced Search field: *"project-based learning" AND "cognitive" AND "early childhood"*

This string yielded 1,554 records in Scopus alone. Complementary searches in SINTA and DOAJ used equivalent keyword combinations in Indonesian and English. All searches were restricted to publications from January 2020 to March 2026 to capture recent developments while ensuring adequate bibliographic density.

2.3 Inclusion and Exclusion Criteria

Articles were assessed against pre-specified criteria. Inclusion criteria: (1) publication between 2020 and 2026; (2) focus on children aged 0–8 years in ECE, kindergarten, or early primary settings; (3) PjBL implemented as the primary or co-primary instructional approach; (4) at least one cognitive outcome variable explicitly measured or synthesised. Exclusion criteria: (1) non-empirical opinion articles or editorials; (2) studies addressing exclusively affective or psychomotor outcomes without any cognitive component; (3) non-peer-reviewed grey literature; (4) full text inaccessible after two retrieval attempts.

2.4 Data Selection and Extraction

Following a two-stage screening process (title/abstract, then full text), 22 articles were retained for final synthesis: 10 from Scopus and 12 from SINTA/DOAJ. The complete PRISMA-based selection flow is documented in Table 1. Data were extracted using a structured form capturing: bibliographic details, study design, sample characteristics, PjBL implementation description, cognitive outcome variables, measurement instruments, and key findings. Thematic content analysis was then applied, using inductive coding to identify recurring cognitive themes across the corpus.

Table 1. PRISMA-Based Article Selection Flow

No	PRISMA Stage	Records In	Records Out	Records Kept	Action / Criteria
1	Identification	1,554	—	1,554	Scopus + SINTA + DOAJ + Google Scholar; keywords: PjBL + cognitive + early childhood (2020–2026)
2	Deduplication	1,554	~100	~1,454	Remove book chapters, editorials, non-peer-reviewed, non-English without abstract
3	Title & Keyword Screening	1,454	~1,433	21	Automated match: all 3 variables (PjBL + cognitive + ECE) present in title/abstract/keywords
4	Abstract Screening	21	11	10	Manual review: ECE focus, PjBL as main approach, cognitive outcome explicitly measured
5	Full-Text Eligibility	22*	0	22	*12 local (SINTA/DOAJ) + 10 Scopus; apply final inclusion/exclusion criteria
6	Final Included	22	0	22	22 articles: 10 Scopus-indexed + 12 local peer-reviewed (SINTA/DOAJ)

Note. *The 12 local articles (from SINTA and DOAJ) entered the pipeline at Stage 5 as they were retrieved through separate database searches and pre-screened independently. Total final corpus = 22 articles. PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

3. Results

The 22 articles included in this review (Table 2) represent a methodologically diverse corpus: two experimental studies, five quasi-experimental, two R&D (ADDIE-based), four descriptive qualitative, one classroom action research, one module development, and seven literature/systematic reviews. Sample sizes in primary studies ranged from 11 preschoolers (Hidayah et al., 2025) to 73 children across multiple institutions (Herlina et al., 2026), with one Scopus study involving 72 ECE teachers as participants (Pratiwi et al., 2025). Geographically, 12 studies were conducted in Indonesian ECE contexts, while 10 were conducted internationally (Australia, China, Russia, Kazakhstan, Malaysia, Saudi Arabia, Taiwan). This dual composition enables both an in-depth analysis of PjBL in the Indonesian setting and a systematic cross-cultural validation of key findings.

Table 2. Methodological Profile of All Included Studies (N = 22)

No	Author / Year	Method	Sample	Cognitive Variable	Key Findings	Source
Local Articles — SINTA / DOAJ (n = 12)						
1	Herlina et al. (2026)	R&D ADDIE	73 preschoolers	Cognitive & creativity	PjBL+loose parts valid & practical; sig. gains in observation, classification, problem-solving (p=.000) across A/B/C-accredited preschools.	Local
2	Hidayah et al. (2025)	Desc. qualitative	11 preschoolers	Cognitive & social	Ecobrick-PjBL: 70% children met success criteria after 4 weeks; improved analytical thinking in environmental context.	Local
3	Permatasari et al. (2025)	SLR	20 articles	Critical thinking, classification	PjBL consistently contributes to ECE cognition; strengthens independence and early literacy.	Local
4	Ummaroch et al. (2025)	Desc. qualitative review	ECE & SD articles	Critical thinking, problem-solving	PjBL aligns with preoperational stage; enhances symbolic reasoning and logical thinking.	Local
5	Cahyaningsih & Harun (2023)	Quasi-experimental	Kindergarten B	Critical thinking & creativity	PjBL significantly improves critical thinking and creativity (statistically significant result).	Local
6	Nikmah et al. (2023)	Literature review	ECE articles	Creativity & self-regulation	PjBL increases idea fluency and material flexibility; strengthens self-regulation in ECE.	Local
7	Sukardjo et al. (2023)	Literature review	ECE children	4C competencies	Loose parts stimulate all 4C: creativity, critical thinking, communication, collaboration.	Local
8	Lestarinigrum & Wijaya (2020)	CAR	Children 4–5 yrs	Simple problem-solving	Loose parts in project framework improves problem-solving independence significantly.	Local
9	Imamah & Muqowim (2020)	Literature review	ECE children	Creativity & critical thinking	STEAM+loose parts+PjBL synergistically develops creativity and critical thinking.	Local
10	Amelia & Aisya (2021)	Desc. qualitative	TK IT Al-Farabi	Mastery of basic concepts	PjBL deepens conceptual understanding through real-context application.	Local
11	Siminto et al. (2025)	Literature review	ECE & primary	Creativity & cognitive collaboration	PjBL shifts learning from passive to active; builds social cognition foundation.	Local
12	Baity & Faiqoh (2022)	Literature review	ECE children	Problem-solving	PjBL develops problem-solving through plan–act–reflect project cycles.	Local
Scopus-Indexed Articles (n = 10)						
13	Kuo (2025)	Quasi-experimental	Students (TPSP course)	Creative thinking	STEAM-PBL (Tri-Phase) significantly improved creative thinking across multiple subject areas.	Scopus
14	Plotnikova et al. (2025)	Experimental	Preschoolers (ECE)	Executive function, socio-emotional	PjBL improved executive functions and socio-emotional development; sig. gains over control.	Scopus
15	Ghazali et al. (2025)	Module development	Preschool children	Creative thinking, early science	TPBL module effectively fostered creative thinking in early childhood science learning.	Scopus
16	Chen et al. (2026)	Experimental	Young children	Computational thinking, exec. function	Incremental PjBL robot programming improved computational thinking and executive function.	Scopus
17	Zhang et al. (2026)	Quasi-experimental	Preschool children	Creativity	Reverse engineering+PjBL enhanced creativity stronger than conventional PjBL alone.	Scopus
18	Pratiwi et al. (2025)	Qualitative	72 ECE teachers (Indonesia)	Teacher adaptation, ECE reform	ECE teachers face challenges in Kurikulum Merdeka; PjBL central to reform context.	Scopus
19	Alibek & Akhmetova (2025)	Systematic Review	Kindergarten (STEM SLR)	Cognitive skill development	STEM/STEAM education develops cognitive skills in kindergarten; aligned with PjBL framework.	Scopus
20	Veraksa et al. (2024)	Experimental (pilot)	Preschoolers 5–6 yrs	Executive function, social competence	PjBL improved social competence; executive function moderated the effect.	Scopus
21	Albar & Southcott (2021)	Quasi-experimental	Foundation class (Australia)	Creative thinking, 21C skills	PjBL investigation lessons: sig. gains in creative thinking in ECE (Australian context).	Scopus
22	Alromaih et al. (2022)	Descriptive-analytical	Pre-service ECE teachers	Instructional design, PjBL perceptions	PjBL training improved instructional design process for pre-service ECE teachers.	Scopus

Note. ECE = Early Childhood Education; PjBL = Project-Based Learning; CAR = Classroom Action Research; SLR = Systematic Literature Review; 4C = Creativity, Critical Thinking, Communication, Collaboration; STEM = Science, Technology, Engineering, Mathematics. Source: L = Local (SINTA/DOAJ); S = Scopus-indexed.

Thematic analysis of the 22 studies yielded seven superordinate cognitive themes with varying frequencies across the corpus (Table 3). These themes are presented below in descending order of evidential frequency.

Table 3. Frequency of Cognitive Themes Across All 22 Included Studies

Cognitive Theme	n	% Studies	Representative Studies
Critical & reflective thinking	17	77%	Ummaroch et al., 2025; Cahyaningsih & Harun, 2023; Kuo, 2025; Albar & Southcott, 2021; Alibek & Akhmetova, 2025; + 12 others
Creativity & creative expression	15	68%	Herlina et al., 2026; Nikmah et al., 2023; Ghazali et al., 2025; Zhang et al., 2026; Albar & Southcott, 2021; + 10 others
Problem-solving	14	64%	Herlina et al., 2026; Lestarinigrum & Wijaya, 2020; Baity & Faiqoh, 2022; Plotnikova et al., 2025; + 10 others
Observation & classification	10	45%	Herlina et al., 2026; Permatasari et al., 2025; Sukardjo et al., 2023; + 7 others
Executive function	7	32%	Chen et al., 2026; Plotnikova et al., 2025; Veraksa et al., 2024; + 4 others
Independence & self-regulation	9	41%	Nikmah et al., 2023; Siminto et al., 2025; Amelia & Aisya, 2021; + 6 others
4C / 21st-century competencies	8	36%	Sukardjo et al., 2023; Albar & Southcott, 2021; Alibek & Akhmetova, 2025; + 5 others

Note. *n* = number of included studies (out of 22) explicitly addressing each cognitive theme. Studies may address multiple themes; total exceeds 22. Percentages rounded to nearest whole number.

3.1 Critical and Reflective Thinking (n = 17; 77%)

Critical thinking constituted the most pervasive cognitive theme across the reviewed corpus, appearing in 17 of 22 studies. In Indonesian ECE contexts, Ummaroch et al. (2025) demonstrate that PjBL's open-ended problem structure nurtures children's disposition to ask 'why' and 'how' without predetermined answers, laying the reasoning foundations that Piaget associates with the transition from preoperational to concrete operational thought. The ecobrick project documented by Hidayah et al. (2025) provides a particularly vivid illustration: guided sorting of organic and inorganic waste constituted applied analytical reasoning embedded in an authentic environmental context.

International evidence substantiates these findings. Kuo (2025), in a Scopus-indexed quasi-experimental study, demonstrated that a Tri-Phase STEAM-PBL framework significantly elevated creative and critical thinking scores across multiple subject areas, with effect sizes consistent across diverse student groups. Albar and Southcott (2021), studying Australian foundation-year classrooms, documented statistically significant gains in creative thinking behaviour through PjBL investigation lessons, confirming that the mechanism of effect is not limited to Indonesian ECE contexts. Alibek and Akhmetova (2025), in a PRISMA-based systematic review of STEM/STEAM education in kindergarten children, converge on the same finding: integrated, inquiry-driven approaches of which PjBL is the paradigmatic example produce broader and deeper cognitive gains than skills-based drilling, regardless of national context.

3.2 Creativity and Creative Expression (n = 15; 68%)

Creativity emerged as the second most frequently documented cognitive outcome, addressed in 15 studies. Herlina et al. (2026) operationalised creativity through four measurable indicators idea fluency, material flexibility, idea originality, and elaboration and reported statistically significant improvement ($p = .000$) across all four following loose-parts-based PjBL implementation in preschools of varied accreditation levels. Nikmah et al. (2023)

report analogous gains in ECE, evidenced by children generating more varied ideas and sustaining internal motivation throughout project cycles.

Scopus-indexed international studies corroborate and extend these findings. Zhang et al. (2026), in a quasi-experimental study of preschool STEM education in China, found that reverse engineering pedagogy embedded in PjBL produced significantly greater creativity gains than conventional PjBL alone suggesting that methodological variations within the PjBL family can produce differential creativity outcomes that merit further investigation. Ghazali et al. (2025), developing and evaluating a Technology-Project-based Learning module in Malaysian preschools, found significant improvements in children's creative thinking skills in early science learning. The convergence of evidence from Indonesia, China, Malaysia, and Australia collectively establishes that PjBL's creativity-fostering mechanism is robust and cross-culturally replicable.

3.3 Problem-Solving Abilities (n = 14; 64%)

Problem-solving operationalised as the capacity to identify a challenge, generate solutions, test alternatives, and reflect on outcomes was evidenced in 14 of 22 studies and represents one of PjBL's most theoretically central cognitive objectives. Lestarinigrum and Wijaya (2020) demonstrate through classroom action research that children aged four to five years who engaged in loose parts play within a project framework exhibited markedly greater willingness to experiment and greater independence in solution-finding. Baity and Faiqoh (2022) identify the plan-act-reflect cycle inherent in PjBL as the structural mechanism driving this development.

Executive function components specifically inhibitory control and cognitive flexibility emerged as a related dimension in Scopus-indexed international evidence. Plotnikova et al. (2025), in a Russian experimental study, documented significant improvements in executive functions following PjBL participation in preschool children, with these gains predicting subsequent socio-emotional development. Veraksa et al. (2024) found that executive function level at baseline moderated the magnitude of PjBL gains in social competence, suggesting that children with higher baseline executive function benefit most strongly from PjBL a finding with direct implications for differentiated ECE instruction. Chen et al. (2026), in an experimental study of young children's robot programming, demonstrated that incremental PjBL significantly improved both computational thinking and executive function, confirming that problem-solving and executive regulatory processes are co-activated and co-developed within well-structured PjBL contexts.

3.4 Observation, Classification, and Basic Concept Mastery (n = 10; 45%)

Observation and classification represent the cognitive processes most directly tied to young children's sensorimotor engagement with the physical world, and PjBL particularly when enriched with loose parts is uniquely positioned to cultivate them. Herlina et al. (2026) measured these abilities across three operationalised indicators object observation, attribute-based grouping, and simple problem resolution finding statistically significant improvement ($p = .000$) across all three. Sukardjo et al. (2023) demonstrate that the multisensory properties of loose parts (texture, weight, colour, shape) naturally elicit observation and classification behaviour as children compare, match, and sort materials within project activities.

Amelia and Aisya (2021) extend this to the domain of basic concept mastery, arguing that PjBL ensures deeper conceptual understanding because children actively apply rather than passively receive concepts within authentic project contexts. This aligns with Bruner's enactive and iconic representation stages, wherein knowledge consolidates most effectively when children first manipulate, then represent, and finally symbolise their experiences.

3.5 Independence, Self-Regulation, and Cognitive Creativity (n = 9; 41%)

Independence and self-regulation dimensions of the broader executive function cluster were addressed in nine studies and are conceptually intertwined with creativity in the PjBL literature. When children are given autonomy to select project themes, determine work sequences, and evaluate outcomes, they become accountable for their own learning processes

and develop the metacognitive monitoring that underpins effective self-regulation (Nikmah et al., 2023; Siminto et al., 2025). Plotnikova et al. (2025) provide experimental evidence that PjBL strengthens executive-function-mediated self-regulation in preschoolers, with gains observed in inhibitory control and behavioural flexibility. Alromaih et al. (2022) further demonstrate that PjBL training for pre-service ECE teachers improves their capacity to design self-directed learning environments, establishing a pedagogical chain of effect: better-prepared teachers implement higher-quality PjBL, which in turn fosters children's autonomy and self-regulation more effectively.

3.6 The Integrative Role of Loose Parts Media

Across the 22-study corpus, loose parts emerged as the single most consistent contextual amplifier of PjBL's cognitive impact. As open-ended materials with no predetermined affordance, loose parts simultaneously demand and develop the full range of cognitive skills identified in this review observation, classification, problem-solving, creative thinking, and reflective inquiry within a single integrated learning episode (Herlina et al., 2026; Sukardjo et al., 2023). When embedded in PjBL, these activities are oriented toward purposeful goals that provide the directional structure that unguided loose parts play may lack. This pedagogical synergy loose parts providing material richness, PjBL providing purposive framework constitutes what the present review identifies as an optimal design principle for ECE cognitive stimulation, analogous to what Vygotsky termed a psychological tool: a material mediator that extends children's cognitive reach beyond unaided thought.

4. Discussion

The convergent findings of this 22-study systematic review provide robust multi-source evidence that PjBL constitutes a developmentally appropriate and cognitively efficacious approach for early childhood education. When interrogated against the constructivist theoretical traditions, the findings achieve strong theoretical coherence. Piaget's account of the preoperational child as an active symbol-user who learns through concrete manipulation is directly instantiated in every PjBL project that requires a young child to build, sort, construct, or assemble. Vygotsky's ZPD is operationalised through teacher scaffolding within the project cycle posing guiding questions, providing just-in-time assistance, and gradually withdrawing support as competency consolidates (Vygotsky, 1978). Bruner's emphasis on enactive, iconic, and symbolic representation is realised as children progress from physically manipulating materials to drawing, describing, and finally abstractly conceptualising their project experiences.

A critical finding of this review is that PjBL operates multidimensionally within a single project cycle, simultaneously cultivating critical thinking, observation, problem-solving, creativity, and executive function. This is not simply an additive effect but a synergistic one: the open-ended problem structure demands critical inquiry, the physical materials afford observation and classification, the solution-generation phase requires problem-solving, and the evaluation phase consolidates metacognitive self-regulation. Alibek and Akhmetova (2025) converge on this conclusion in their Scopus-indexed systematic review of STEM kindergarten education, observing that integrated inquiry-driven approaches produce consistently broader cognitive gains than isolated skill instruction. The implication for ECE curriculum design is significant: PjBL is not merely an alternative instructional strategy but a meta-pedagogical architecture that subsumes multiple developmental objectives within a unified, experience-based sequence.

The international dimension of this review substantially strengthens the evidential base. The consistency of findings across Australian (Albar & Southcott, 2021), Chinese (Chen et al., 2026; Zhang et al., 2026), Russian (Plotnikova et al., 2025; Veraksa et al., 2024), Kazakh (Alibek & Akhmetova, 2025), Malaysian (Ghazali et al., 2025), and Indonesian contexts suggests that PjBL's cognitive benefits are not culturally bound but instead reflect universal mechanisms of constructivist learning. Nevertheless, contextual factors including teacher preparation quality, curriculum policy, resource availability, and cultural norms around child autonomy moderate

the magnitude of these effects. Pratiwi et al.'s (2025) Scopus-indexed qualitative study of Indonesian rural ECE teachers highlights the critical role of teacher readiness: educators who lack adequate preparation for PjBL risk implementing surface-level activities that fail to engage children's higher-order thinking. Alromaih et al.'s (2022) parallel finding that PjBL training for pre-service ECE teachers directly improves their instructional design capacity confirms that teacher professional development is a necessary condition for high-quality PjBL implementation.

Several methodological limitations warrant candid acknowledgement. First, nine of the 12 local studies employed pre-experimental or descriptive designs without control groups, constraining causal inference. Effect sizes were rarely reported, precluding quantitative comparison or meta-analytic synthesis. Second, the Scopus-derived studies, while broadening geographical coverage, introduce heterogeneity in outcome measurement and PjBL conceptualisation that complicates direct comparison. Third, the inclusion of secondary reviews among primary empirical studies introduces a risk of double-counting primary evidence; future systematic reviews should segregate these categories. Fourth, the noted inconsistency between the stated inclusion period (2021–2026 in the original protocol) and the actual retrieved articles (2020–2026) has been addressed here by expanding the formal period to 2020–2026 and documenting this adjustment transparently. These limitations notwithstanding, the volume, diversity, and international range of the included evidence collectively constitute a substantially stronger evidential base than any single-database or single-country review could provide.

5. Conclusion

This systematic literature review synthesised evidence from 22 peer-reviewed studies (10 Scopus-indexed, 12 local) published between 2020 and 2026 to examine the role of PjBL in promoting cognitive development in early childhood. Seven cognitive themes were identified and quantified across the corpus: critical thinking (77%), creativity (68%), problem-solving (64%), observation and classification (45%), independence and self-regulation (41%), executive function (32%), and 4C/21st-century competencies (36%). These themes align with the constructivist theoretical foundations of Piaget, Vygotsky, and Bruner, and are corroborated by international Scopus-indexed evidence from Australia, China, Russia, Kazakhstan, Malaysia, and Saudi Arabia, lending the findings a degree of cross-cultural robustness that extends well beyond Indonesian ECE alone.

The loose parts–PjBL synergy emerged as an optimal pedagogical design principle: loose parts provide the material richness and sensory diversity that expand cognitive demands within PjBL, while PjBL provides the purposive framework that directs loose parts exploration toward meaningful learning goals. Together, they constitute a developmentally complete ECE learning environment that cultivates the full spectrum of cognitive competencies young children require for subsequent academic success.

For ECE practitioners, the implication is direct: PjBL particularly when enriched with loose parts is not a supplementary enrichment activity but a cognitively essential pedagogical strategy that should be systematically embedded across the ECE curriculum. For institutional leaders, sustained investment in teacher professional development focused on PjBL facilitation, authentic project design, and formative cognitive assessment is a necessary precondition for implementation quality. For policymakers, the evidence base fully supports the integration of PjBL principles within Kurikulum Merdeka implementation guidelines as a coherent, empirically grounded approach to ECE quality improvement.

Future research should prioritise: (1) randomised controlled trials or matched quasi-experimental studies to establish causal claims; (2) longitudinal designs tracking the persistence of PjBL-induced cognitive gains into primary school; (3) measurement of specific executive function components (inhibitory control, working memory, cognitive flexibility) as discrete outcomes; (4) comparative studies contrasting PjBL with and without loose parts

media to isolate the loose parts effect; and (5) multi-country comparative studies designed to examine how cultural and institutional contexts moderate PjBL's cognitive impact.

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