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The Efficacy of Project-Based Learning in Fostering Linguistic and Motor Development in Early Childhood

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ABSTRACT
The aim of this study is to determine the effectiveness of project-based learning (PjBL) in enhancing the linguistic and motor intelligence of early childhood students. A mixed-method approach was employed, combining quantitative data from child development rubrics with qualitative data from observations, interviews, and activity documentation. An experimental design was used, with a control group following conventional learning methods and an experimental group receiving project-based learning. The findings indicate that PjBL techniques significantly improve linguistic and motor intelligence. Specifically, the average linguistic intelligence score of the experimental group increased from 62.4 (pre-test) to 83.7 (post-test), while motor intelligence scores rose from 58.9 to 80.1. Through creative activities such as making picture stories and engaging in collaborative play, children in the experimental group demonstrated enhanced speaking, writing, and both fine and gross motor skills. Qualitative analysis also revealed increased confidence, teamwork, and emotional engagement among the children. Key success factors included teacher training, parental involvement, and a supportive learning environment. These findings have practical implications for educators, policymakers, and parents: integrating PjBL into early childhood curricula can foster holistic child development, improve school readiness, and bridge the gap between academic and socio-emotional growth. Supporting this approach through policy, curriculum planning, and parental outreach is essential for sustainable implementation.

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1. *Introduction*

Early Childhood Education (ECE) serves as the cornerstone of human development, shaping children's cognitive, affective, and psychomotor capacities in ways that influence their lifelong learning trajectories. The period from birth to six years, often regarded as the golden age, represents a critical developmental window when neuroplasticity is at its peak and the brain's neural architecture is most responsive to environmental stimulation (Khaironi, 2017; Amalia & Khoiriyati, 2018; Parsons & McCormick, 2024). During this sensitive phase, well-designed pedagogical experiences that integrate sensory, linguistic, and motor stimuli have been shown to enhance both intellectual and socio-emotional growth (Brown & Jernigan, 2012; Mou et al., 2024; Merlo et al., 2024; Li, 2024). Consequently, the design of early learning curricula must adopt a holistic and integrative approach, emphasizing the interplay between linguistic and motor development—two fundamental domains that collectively determine a child's capacity for communication, cognition, and adaptation (Angrist et al., 2024; Beerannavar & Pancrasius, 2024; Pyle et al., 2024).

Linguistic intelligence, as conceptualized by Gardner's theory of multiple intelligences, refers to the ability to comprehend, use, and express language effectively across oral and written modalities (Rahmi & Septiana, 2023; Johri et al., 2025; Gluck et al., 2025). In early childhood, it not only facilitates communication but also underpins reasoning, imagination, and problem-solving skills. Meanwhile, motor development—both gross and fine—supports the acquisition of functional independence and the execution of tasks requiring precision, such as writing and manipulating learning tools (Gonzalez et al., 2019). These two domains are interdependent; activities such as storytelling, drawing, or role-play necessitate coordination between verbal expression and motor control, reinforcing cognitive-motor synchronization (Tang et al., 2024; Jiménez et al., 2024).

However, despite their developmental importance, many young children in Indonesia experience delays in linguistic and motor development, often attributed to pedagogical constraints and systemic inequities in access to quality early education. Traditional teacher-centered approaches, limited creative learning materials, and insufficient exposure to interactive learning environments hinder optimal developmental outcomes (Razi et al., 2025; Raise the Bar: Overview, 2025). These persistent challenges underscore the urgency of adopting innovative, child-centered pedagogical models that promote active participation, experiential learning, and multidimensional skill integration.

One pedagogical framework that has gained global recognition for addressing these developmental needs is Project-Based Learning (PjBL). Grounded in constructivist and socio-cultural learning theories (Kogan & Pin, 2009; Shue, 2008; Vygotsky, 1978), PjBL engages children in collaborative, hands-on, and inquiry-driven activities that connect abstract concepts with real-life experiences. Within the ECE context, PjBL encourages children to explore ideas, communicate, solve problems, and reflect on their learning processes. It stimulates linguistic intelligence through verbal interaction, narrative construction, dramatization, and peer communication (Mushtaq et al., 2025; Gluck et al., 2025), while simultaneously developing motor proficiency through creative tasks—such as crafting, building, designing, and manipulating objects—that require coordination and planning (Era et al., 2025). For instance, constructing a miniature ecosystem or diorama from recycled materials engages both verbal reasoning and fine motor control, thereby fostering the integration of thought, language, and action.

Despite these pedagogical benefits, the implementation of PjBL in Indonesian PAUD (Pendidikan Anak Usia Dini) remains relatively limited. Many early childhood educators lack structured professional development, institutional support, or resource access necessary for effective PjBL integration (Ros et al., 2025). Moreover, existing research tends to focus on PjBL outcomes in primary and secondary education, emphasizing cognitive and socio-emotional domains, while studies examining its impact on linguistic and motor development in early childhood are scarce (Raihan, 2024; Kurniati, 2021; Rahmi & Septiana, 2023). This research gap is particularly relevant in Indonesia, where regional disparities, curriculum constraints, and sociocultural variations shape pedagogical practice and child development outcomes differently across contexts.

Therefore, the present study aims to empirically investigate the efficacy of Project-Based Learning in promoting linguistic and motor development among early childhood learners in Indonesia. By employing a mixed-methods design, this research integrates quantitative data (pre- and post-tests, developmental rubrics) with qualitative evidence (teacher interviews, classroom observations, and parental feedback) to yield a comprehensive understanding of PjBL implementation. The findings are expected to elucidate the mechanisms through which PjBL facilitates developmental growth, identify contextual enablers and barriers, and generate evidence-based policy recommendations for enhancing PjBL practices within resource-constrained PAUD environments.

In essence, this study contributes to the theoretical discourse and practical advancement of early childhood pedagogy, aligning with Indonesia's broader educational reform agenda to cultivate competent, creative, and character-driven learners prepared for the challenges of the 21st century.

2. Method

Research Design

This study employed a mixed-methods design integrating quantitative and qualitative data collection and analysis (Barry, 2020; Najjar et al., 2025). The combination of these two approaches enabled a more comprehensive evaluation of the effectiveness of Project-Based Learning (PjBL) in enhancing both linguistic and motor development among early childhood learners. The quantitative component measured the magnitude of learning outcomes, while the qualitative strand explored the contextual experiences and behavioral changes of children and teachers. Together, these complementary data sources offered a holistic understanding of how PjBL functions in authentic early childhood education (ECE) environments. A quasi-experimental design with a non-equivalent control group structure was applied. Two groups were established:

1) an experimental group that received PjBL intervention, and
2) a control group that continued conventional instruction.

Each group consisted of 15 children aged 5–6 years, randomly selected from an urban ECE center. Participants were matched based on age, socioeconomic background, and baseline developmental levels to ensure group comparability. The total sample (n = 30) adhered to the minimum sample requirements for pilot intervention research in early childhood settings (Laoli, 2021; Halim & Zulkefli, 2021). Although no formal power analysis was conducted due to resource limitations, the sample size was sufficient for detecting moderate effect sizes using t-tests and ANOVA (Lehmann et al., 2024; Gajderowicz et al., 2025).

Research Context and Duration

The study was implemented over a six-week period at a private early childhood education center in Jakarta, Indonesia. Both groups participated in weekly thematic sessions aligned with the national ECE curriculum.

1) The experimental group engaged in PjBL-based activities such as composing illustrated storybooks, constructing mini-gardens, and performing collaborative role-play.
2) The control group followed a traditional teacher-centered approach, relying on textbooks, worksheets, and direct instruction.

Teacher Training and Parental Involvement

To ensure fidelity of implementation, teachers assigned to the experimental group underwent specialized PjBL training, consisting of four 2-hour workshops conducted over two weeks. These sessions covered PjBL philosophy, project planning, classroom facilitation, and authentic assessment strategies. Practical simulations and peer reflections were incorporated to strengthen teacher competence and instructional readiness. Parental involvement formed an integral component of the intervention. Parents in the experimental group received a home-support guidebook containing practical tips on encouraging children's participation in projects—such as asking reflective questions, giving constructive feedback, and documenting observations through photos or brief notes. Weekly communication between parents and teachers was facilitated through in-person meetings or digital platforms to maintain consistency and monitor home-based learning engagement.

Research Procedure

The research was conducted in three structured phases:

1) Preparation Phase – designing age-appropriate project modules and aligning them with the national ECE thematic framework.
2) Implementation Phase – conducting PjBL sessions across six weeks while simultaneously collecting field data.
3) Evaluation Phase – analyzing quantitative and qualitative findings, followed by integrating results through triangulation (Brushe, 2024; Yim & Su, 2024).

The instruments used were:

Instrument	Function	Data Collection Method
Development Rubric	**Measuring linguistic and motor skill improvements**	**Pre- and post-test observation**
Interviews	**Capturing teacher and parent perspectives**	**Structured and semi-structured formats**
Observation	**Documenting children's engagement and progress**	**Field notes and behavioral checklists**
Documentation	**Providing visual and contextual data**	**Photos, videos, and student work samples**

Data Collection and Analysis

Children's developmental progress was assessed using a standardized rubric adapted from the national ECE competency framework, focusing on indicators of linguistic development (e.g., vocabulary use, storytelling, sentence formation) and motor skills (e.g., hand–eye coordination, grip control, fine motor precision). Direct observations were conducted throughout classroom activities using structured observation sheets and checklists. In-depth interviews with teachers and parents were transcribed verbatim to gain nuanced insights into behavioral and skill changes. Quantitative data were analyzed using descriptive statistics (mean, standard deviation) and inferential statistics (independent samples t-test and one-way ANOVA) to determine significant differences between pre- and post-test results across groups (Rocha et al., 2024; Koga, 2024; Djaker et al., 2024). Qualitative data were analyzed through thematic coding, involving data immersion, pattern identification, and category refinement to extract emergent themes related to engagement, learning challenges, and perceived developmental benefits (Horne & Rakedzon, 2024; Allouche, 2024).

To ensure validity and reliability, the study applied methodological triangulation, integrating findings from quantitative, qualitative, and visual documentation sources. The use of multiple data types provided confirmatory evidence of the outcomes and minimized potential bias. This analytical framework allowed for a nuanced understanding of how Project-Based Learning contributes to children's linguistic and motor development within early childhood educational contexts (Nyqvist & Guariso, 2024; Waheed et al., 2024).*Result And Discussion*

3. Result

The analysis of the pre-test and post-test data revealed a statistically significant improvement in the experimental group compared to the control group, particularly in the domains of linguistic and motor intelligence. The mean post-test scores in the experimental group showed a substantial increase, and the independent samples t-test confirmed a significant difference at the 0.05 level ($p < 0.05$). These

findings indicate that the implementation of Project-Based Learning (PjBL) had a measurable and positive effect on early childhood linguistic and motor development.

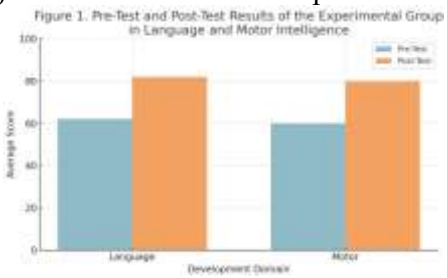

Figure 1. Pre-Test and Post-Test Results of the Experimental Group in Language and Motor Intelligence

Complementing the quantitative findings, the qualitative data provided nuanced insights into the developmental changes observed throughout the intervention. By the fourth week of the program, a previously reticent child ("R") began confidently presenting her illustrated story to peers, signifying a marked improvement in verbal fluency and self-confidence. Teachers noted that children became "more fluent, logical, and spontaneous" in expressing their thoughts, with observable gains in vocabulary and narrative structure. Motor development improvements were equally prominent. Activities such as cutting, drawing, arranging story elements, and constructing miniature habitats strengthened children's fine motor coordination, while collaborative outdoor projects reinforced gross motor balance and teamwork.

Parental feedback further substantiated these outcomes. One parent stated, "My daughter now tells stories at home with more detail and confidence. She also enjoys drawing and labeling her pictures." Supporting visual documentation—including photos, video recordings, and student work samples—confirmed increased engagement, collaboration, and purposeful creativity throughout the project cycle. In summary, the integration of quantitative improvements with qualitative evidence demonstrates that PjBL not only enhances children's linguistic and motor competencies but also promotes creativity, confidence, and socio-emotional expression—core components of holistic early childhood development.

4. Discussion

The findings of this study demonstrate that Project-Based Learning (PjBL) effectively fosters multiple dimensions of early childhood development, particularly in linguistic and motor intelligence. This conclusion is supported by robust quantitative gains and qualitative observations, highlighting that PjBL provides young learners with meaningful, integrated, and contextually relevant learning experiences. From a theoretical perspective, these results substantiate Howard Gardner's Theory of Multiple Intelligences, emphasizing the interconnectedness of linguistic and bodily-kinesthetic intelligences during early learning. Through activities such as storytelling, dramatization, collaborative dialogue, and creative construction, children were encouraged to engage their verbal and physical intelligences simultaneously. This multimodal engagement promoted both expressive language growth and coordinated motor responses—an essential synergy in early childhood education (Gardner, 2024).

Moreover, the outcomes strongly align with Vygotsky's Sociocultural Theory, which underscores the importance of social interaction and guided participation in children's cognitive development. Within the PjBL framework, peer collaboration and teacher scaffolding served as mediating mechanisms that facilitated the co-construction of knowledge. The scaffolding process enabled children to operate within their Zone of Proximal Development (ZPD), thereby accelerating their linguistic competence and psychomotor coordination through social mediation and experiential learning.

The present findings also contribute to the expanding body of research on early childhood pedagogy in Southeast Asia. For example, Nguyen and Trần (2024) reported significant gains in literacy and fine motor skills among Vietnamese kindergarteners using project-based tasks, while Admawati and Mutia (2023) demonstrated that PjBL could be effectively adapted in Indonesian early childhood education (ECE) settings with limited material resources. In line with these studies, this research confirms that PjBL remains highly adaptable across varied educational contexts, where creativity, parental engagement, and teacher initiative serve as critical compensatory factors in resource-constrained environments.

However, several limitations should be acknowledged. The relatively small sample size (n = 30) restricts statistical generalizability, and the six-week intervention period may not adequately reflect long-term developmental outcomes. Moreover, the research context—an urban preschool—may differ substantially from rural or under-resourced ECE institutions in Indonesia or neighboring countries. Future research should therefore adopt longitudinal designs, larger and more diverse samples, and cross-institutional comparisons to capture the sustained and scalable impacts of PjBL on children's linguistic, motor, and socio-emotional development. To optimize the implementation of PjBL in early childhood education, particularly in low-resource or community-based contexts, the following recommendations are proposed:

a) Modular and Scalable Project Design
   Teachers can create flexible PjBL modules using local or recycled materials and contextual storytelling approaches. Examples include "My Family Story Bag" or "Nature Collage from the School Garden," which promote creativity at minimal cost.
b) Micro-Training for Educators
   Short, focused professional development sessions can enhance teachers' competence in project facilitation, interdisciplinary integration, and authentic assessment practices.
c) Parent Engagement Kits
   Simple home-activity kits and reflection prompts (e.g., "What did you build or learn today?") can extend learning beyond the classroom and strengthen family-school collaboration.
d) Collaborative Partnerships
   ECE centers should collaborate with local education offices, NGOs, and higher education institutions to access professional support, share resources, and sustain the PjBL approach through community-based networks.

5. Conclusion

This study provides compelling empirical evidence that Project-Based Learning (PjBL) serves as an effective pedagogical model for enhancing both linguistic and motor development in early childhood education. Through the integration of experiential, collaborative, and inquiry-based activities, PjBL enables children to simultaneously develop verbal fluency, fine motor coordination, and socio-emotional awareness. The approach's success lies in its ability to merge cognitive engagement with creative expression—bridging the gap between theoretical constructs of holistic education and the practical realities of classroom implementation.

In answering the research objectives, this study confirms that PjBL significantly improves children's ability to articulate ideas, engage in cooperative problem-solving, and apply motor control in purposeful tasks. Beyond measurable developmental gains, it also nurtures curiosity, confidence, and persistence—key attributes of lifelong learners. These findings underscore the potential of PjBL to strengthen Indonesia's early childhood education system, particularly in promoting equitable and contextually relevant learning models. The study further recommends the integration of modular, low-cost PjBL frameworks into national early childhood curricula, along with systematic teacher training and parental engagement initiatives.

Future research should extend this work through longitudinal and multi-site studies to explore the sustainability of PjBL's developmental impact over time, particularly across diverse geographic and socioeconomic contexts. Investigating the integration of digital literacy, inclusive practices, and socio-emotional learning within PjBL frameworks also presents valuable opportunities for further scholarly inquiry.

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