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Language Development Learning Outcomes: Effectiveness of Project-Based Learning with Mind Mapping

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Abstract: Developing effective and student-centered learning environments in teacher education is crucial for shaping competent future educators. This study examines the impact of integrating *Project-Based Learning (PBL)* with *mind mapping* strategies on students' learning outcomes in the *Child Language Development* course within the Primary School Teacher Education (PGSD) program at Yogyakarta State University (UNY). A quasi-experimental design was employed involving 70 first-semester students, divided equally into experimental and control groups. The experimental group received PBL combined with mind mapping interventions, while the control group followed conventional instruction. Quantitative data were collected through pretests and posttests using validated multiple-choice instruments, and analyzed using the Mann–Whitney U test and normalized gain (n-Gain). Additionally, qualitative reflections from students and lecturers were recorded to capture learning engagement and classroom dynamics. The results revealed a statistically significant improvement in the experimental group's performance ($p < .001$) with a moderate average n-Gain score (0.56), compared to a low score (0.12) in the control group. Observations indicated that students in the experimental group displayed higher creativity, motivation, and collaboration during project completion. The findings affirm that combining PBL with mind mapping enhances cognitive understanding and active participation in language-related learning. This approach not only supports 21st-century learning competencies but also promotes independent and enjoyable learning experiences. The study concludes with pedagogical recommendations for implementing integrated PBL–mind mapping models in teacher education curricula.

Keywords: Language development, Project-Based Learning, Mind Mapping, Learning Outcomes, Teacher Education

Introduction

In the rapidly evolving landscape of higher education, developing future teachers who are competent, reflective, and creative has become a central concern. Teacher education institutions are no longer confined to transferring content knowledge; they are expected to foster critical thinking, problem-solving, and lifelong learning skills (Thomas, 2009). Within this framework, lecturers play a crucial role in designing learning environments that stimulate inquiry, collaboration, and innovation (Loughlin & Lindberg-Sand, 2023). For students in *Primary School Teacher Education (PGSD)* programs, learning should prepare them not only to understand educational theories but also to apply these concepts in authentic classroom contexts.

One of the major challenges in teacher preparation programs is bridging the gap between theory and practice. First-semester students often encounter difficulties grasping abstract concepts such as *child language development*, which forms a foundational aspect of primary education (Hadjioannou & Hutchinson, 2014). Many students tend to memorize definitions and developmental stages rather than developing a conceptual understanding of how children acquire and use language (ALebous, 2025). This limited comprehension has

implications for their future teaching competence, as effective language instruction in elementary classrooms requires both theoretical insight and practical understanding .

Moreover, the current generation of university students—often referred to as "digital natives"—faces unique learning challenges. While they are highly adept at using technology, they frequently struggle with sustained attention, critical reading, and academic writing due to constant exposure to digital distractions (Widiyarti et al., 2020). Consequently, (Hong & Runnalls, 2020) traditional lecture-based methods are increasingly ineffective in maintaining engagement or promoting deep learning. These realities call for transformative approaches that integrate active, visual, and project-oriented learning experiences (Shi et al., 2025) .

In line with these educational shifts, *Project-Based Learning (PBL)* has gained widespread recognition as a powerful student-centered pedagogical model. PBL situates learning in real-world contexts by engaging students in complex projects that require research, collaboration, and problem-solving. As emphasized by Panasan & Nuangchalerm (2010), this approach nurtures both cognitive and metacognitive growth through authentic tasks that bridge theory and practice. Similarly, highlight that PBL fosters the "4Cs" of 21st-century education—critical thinking, creativity, communication, and collaboration—which are essential for preparing future teachers to navigate dynamic classroom realities .

In parallel, *mind mapping* introduced by Tony Buzan (1893) offers a visual-cognitive strategy for organizing ideas, enhancing memory retention, and stimulating creativity. Mind maps enable learners to represent knowledge through interlinked nodes radiating from a central concept, integrating textual and visual thinking. Recent studies show that mind mapping significantly improves comprehension and engagement, particularly when dealing with abstract or complex information (Hariyadi et al., 2023; Sari et al., 2024) .Within the context of teacher education, it can help students visually connect developmental theories, linguistic stages, and pedagogical strategies, making the material more memorable and meaningful.

Although both PBL and mind mapping have proven individually effective, empirical studies combining these two approaches remain scarce, particularly in the domain of teacher education and language learning (Hidayati et al., 2021). Most prior research has focused on science or technical subjects, leaving a gap in understanding how integrated visual and project-based strategies can enhance pedagogical learning in early childhood or language development courses (Akyol et al., 2022) . Addressing this gap is crucial, as these subjects require not only conceptual mastery but also creative interpretation skills that are directly relevant to teachers' future practice in elementary classrooms.

Furthermore, within Indonesia's education system, the emphasis on competency-based curricula demands learning models that go beyond rote memorization. Elementary school teachers' students are expected to internalize the concept of *language as a developmental and social process* rather than a set of linguistic facts (Yusupova et al., 2025) . Yet, conventional instructional methods often fail to stimulate inquiry and visualization of such processes. By combining PBL and mind mapping, students can actively construct knowledge by creating visual representations of language development theories while collaborating on projects that mirror real classroom challenges (Hidayati et al., 2023).

This integrated approach also aligns with the constructivist view of learning, where knowledge is actively built through experience and reflection. In a PBL and mind mapping context, students are not passive recipients but active creators of meaning (Jamhari et al., 2025). They engage in analyzing case studies of children's language acquisition, designing concept maps that link developmental stages, and presenting projects that demonstrate their understanding (Manuaba & Swari, 2022). Such experiences not only strengthen cognitive outcomes but also build affective and psychomotor dimensions confidence, communication, and creativity.

Empirical evidence from related studies supports the potential of this integration. For example, Widiastuti et al. (2024) found that PBL, when supported by visual tools, improved linguistic intelligence and writing performance among pre-service teachers. Similarly, Hariyadi et al. (2023) demonstrated that STEM-based mind mapping enhanced students' science literacy and engagement in the context of the 4.0 education revolution. These findings suggest that visual-collaborative learning designs can effectively elevate both understanding and motivation.Therefore, the present research seeks to empirically examine the effectiveness of integrating PBL and mind mapping in improving students' learning outcomes in the child language development course. The study is guided by the following research question:

Does the combination of Project-Based Learning and mind mapping significantly improve the learning outcomes of PGSD UNY students compared to conventional lecture-based instruction?

This research is expected to contribute to both theory and practice. Theoretically, it extends the understanding of how cognitive and visual learning strategies can be integrated in teacher education contexts. Practically, it offers an evidence-based instructional design that can be adopted by lecturers to enhance language-related courses. The findings also hold implications for curriculum designers and policymakers in Indonesia, emphasizing the importance of multimodal, student-centered learning models in higher education. In summary, this study responds to a pressing pedagogical need: empowering pre-service teachers to become active, reflective learners capable of linking theory to practice. By integrating PBL and mind mapping, the research aims not only to improve academic outcomes but also to cultivate creative, self-regulated learners—future teachers who can, in turn, nurture the same qualities in their own students.

Literature Review

Understanding the theoretical underpinnings of *Project-Based Learning (PBL)* and *mind mapping* is essential to contextualize their integration in teacher education. This framework outlines how each component contributes to meaningful learning and how their combination fosters cognitive and creative growth in pre-service teachers studying child language development.

Project-Based Learning (PBL)

Project-Based Learning is a constructivist instructional model that places learners at the center of knowledge construction. Rooted in the theories of Dewey, Piaget, and Vygotsky (Wibowo et al., 2025) PBL views learning as an active process of inquiry in which students generate meaning through experience and reflection. In this model, students engage in authentic projects that resemble real-world challenges, applying theoretical knowledge to solve contextual problems (Vygotsky, 2016). Unlike traditional lecture-based approaches that emphasize information delivery, PBL promotes deeper cognitive engagement by encouraging students to question, research, design, and present solutions collaboratively. In the context of teacher education, these elements translate into opportunities for students to practice designing instructional materials, implementing learning media, and evaluating children's responses. By doing so, pre-service teachers develop practical competencies while simultaneously internalizing educational theories.

Several studies have validated the positive impact of PBL in higher education. For instance, (Santyasa et al., 2020)found that PBL enhanced the "4Cs" critical thinking, creativity, communication, and collaboration—among college students in communication courses. Likewise, Wong et al. (2019) demonstrated that PBL-based flipped classrooms improved students' evidence-based reasoning and motivation. These findings affirm that project-oriented instruction can elevate both cognitive and affective domains, particularly when applied to education programs. These stages not only guide the research design but also form the pedagogical structure through which students explore and articulate their understanding of child language development.

Mind Mapping

Mind mapping is a cognitive visualization technique developed by Alomery and Hazaymeh (2022) to enhance memory, creativity, and comprehension. A mind map represents information in a radial, non-linear diagram that connects concepts through branches and sub-branches, integrating linguistic and visual cues. The human brain naturally associates ideas through imagery and pattern recognition; thus, mind maps mirror the way knowledge is stored and retrieved cognitively(Abdallah, 2024). In educational settings, mind mapping has been widely used to support note-taking, concept formation, and creative problem-solving (Al-Inbari et al., 2023). It enables learners to see the "big picture" of a topic while understanding hierarchical relationships among sub-concepts. According to dual coding theory combining verbal and visual elements in learning enhances memory retention and conceptual understanding because both channels (linguistic and visual) reinforce each other (Ghilay, 2024).

Empirical research supports the effectiveness of mind mapping in improving students' learning performance and motivation. Charusapsodsai and Intasena (2024) revealed that mind mapping in reading comprehension significantly improved science literacy and critical thinking. Similarly, Özsoy and Saribaş (2021) found that inquiry-based mind mapping boosted students' motivation and analytical skills. Mind maps also promote learner autonomy, as students independently construct meaning by representing their thoughts visually. This sense of ownership leads to higher engagement and self-regulated learning.

In teacher education, mind mapping offers several pedagogical advantages (Berta & Nigus, 2024). First, it encourages future teachers to visualize theoretical constructs and teaching models. Second, it helps them practice simplifying complex topics an essential skill when explaining abstract ideas (Bhattacharya & Mohalik, 2020) to students. Finally, it develops creative confidence, as students use colors, symbols, and images to represent their understanding, aligning with the affective goals of education (Jampel &Widiana, 2016).

The integration of PBL and mind mapping represents a synthesis of constructivist and cognitive theories. While PBL situates learning within authentic, social contexts, mind mapping serves as a cognitive tool to organize and visualize knowledge throughout the project process. The complementary nature of these approaches can be explained through the Cognitive-Affective-Contextual Model of Learning, where learning effectiveness emerges from the interaction between cognition (understanding), affect (motivation), and context (authenticity).

Method

The current study utilized a 'quasi-experimental' also known as a 'field experiment', which is a type of experimental design used by researchers with influence and control over the selection of participant samples. That is, in a quasi-experiment the researcher does not have the control to test participants randomly, but rather through homogeneity tests. The ability to completely control all study variables and the impact of the treatment on the study group(s) may be limited. However, quasi-experiments still offer valuable insights that contribute to the advancement of research (Ellis & Levy, 2011). This study, also incorporating pretest and posttest measurements to examine the effects of an intervention based on an innovative, unique, and high-quality approach. Two group were mentioned experimental group where the class had gotten the treatment guided Project Based Learning aided by *mind mapping* strategy and control group was conducted by conventional method or self-class program method. Each group was arranged a pretest and posttest.

Participant

The participants consisted of all first-semester PGSD students at Yogyakarta State University (UNY) in the 2024/2025 academic year. Using a saturated sampling technique, two intact classes were selected in class G as the experimental group (n = 35) and Class H as the control group (n = 35) in a total of 70 participants. All students were female and aged between 18 and 20 years, reflecting the gender composition of the PGSD cohort. Before the intervention, both classes showed similar average academic achievements and had no prior experience with either project-based or mind mapping strategies. This homogeneity helped minimize the influence of extraneous variables on the results. The research took place within the Child Language Development course, a compulsory subject in the first semester that introduces students to key theories of linguistic growth, phonological awareness, semantic development, and the implications of language learning in early education.

Data Analyzed

The data were analyzed using a combination of quantitative and qualitative methods. Quantitatively, the Kolmogorov–Smirnov test was applied to assess data normality. Since the results indicated non-normal distributions ($p < .05$), the Mann–Whitney U test was used to compare pretest and posttest scores between the experimental and control groups. To determine the magnitude of improvement, normalized gain (n-Gain) was calculated using the formula $g = (Post - Pre)/(100 - Pre)$. Interpretation of the results followed Hake's (1998) classification: $g > 0.7$ indicates high improvement, $0.3 \leq g \leq 0.7$ represents moderate improvement, and $g < 0.3$ denotes low improvement. This measure provides a standardized way to evaluate conceptual gains relative to the potential maximum improvement as showed in teble 1. Qualitatively, the observational and reflection data were analyzed thematically to identify recurring themes that illustrated behavioral changes, including engagement, creativity, and collaboration.

Table 1. The N-gain equation criteria (Hake's, 1998)

N-Gain Value (g)	Criteria
$0.70 < N - Gain \leq 1.00$	High
$0.30 < N - Gain \leq 0.70$	Moderate
$N - Gain \leq 0.30$	Low

Result and Discussion

Result

Research on learning in child language development lectures was conducted using a project-based learning model assisted by a mind mapping strategy (Guo & Yang, 2012). Different treatment between the experimental group and the control class, the project-based learning process in the experimental class followed 6 syntax/steps: (1) Starts With the Essential Question, (2) Design a Plan for the Project, (3) Creates a Schedule, (4) Monitors the Students and the Progress of the Project, (5) Assess the Outcome, (6) Evaluate the Experiences(Lazić et al., 2021).

The implementation of the project-based learning model in this experimental group was carried out 3 times with 100 minutes for each meetings. The journey to find out the effectiveness of the model when collaborated with mind mapping strategies and products by testing student learning outcomes using pretests and posttests. Previously, a normality test was carried out on the pretest and posttest results to determine the further assumption tests that would be carried out.

Table 2. Normality test results of pretest-posttest results of experimental and control groups

Group	N	p
Experiment	35	0.144
Control	35	<0,001

The results displayed <0.05 can be stated that the pretest and posttest data are not normally distributed. Because the data results are not normally distributed, the pretest and posttest results use the Mann-Whitney U test. The data results are as follows.

Table 3. The summary statistical of pretest and posttest result

	Pretest	Posttest
Mann-Whitney U	363.000	218.000
Z	-2.952	-4.689
Asymp. Sif (2-tailed)	.003	<,001

The results of the statistical calculations above are interpreted at the pretest value, there is a significant difference between each experimental group and the control group ($p = 0.003$). At the posttest value, the difference between the experimental group and the control group is increasingly significant ($p < 0.001$), indicating that the intervention or treatment given to the experimental group has a stronger effect. It can be concluded that the implementation of project-based learning on child language development material for PGSD UNY students has a significant effect on their learning outcomes. Furthermore, the increase in student learning outcomes can be seen from *N-Gain* score explain in the following table 2.

Table2. N-Gain score

Group	Mean n-Gain	Category
Experimental	0.56	Moderate
Control	0.12	Low

Based on the Table 2, students in the experimental group showed a *moderate improvement* in understanding, whereas the control group demonstrated *minimal change*. The moderate n-Gain value suggests that the PBL and mind mapping model contributed meaningfully to cognitive enhancement, though not yet reaching a “high” improvement level likely due to the limited duration of implementation.

Discussion

Beyond numerical improvements, qualitative data from classroom observations revealed important behavioral and affective dimensions of learning. Three dominant themes emerged were engagement**,** creativity**,** and collaboration (Hidayati &Tendrita, 2025)**.** During the first meeting, students initially appeared uncertain and hesitant about the PBL structure. Many had never participated in open-ended project work that required self-directed exploration. However, as the sessions progressed, their level of engagement increased noticeably.

In the experimental class, students were observed discussing theories of language acquisition more actively, using both verbal explanations and visual representations. When constructing their mind maps, they negotiated meaning, clarified terms such as *phonological awareness* and *semantic development*, and used colors and icons to symbolize relationships between cognitive stages and linguistic milestones.

One student wrote in her reflection:

"Creating the mind map made me realize how all aspects of language are connected. I finally understood how children's vocabulary grows through interaction and imitation."

Such reflections highlight that the visual process enabled students to build coherent mental models of complex theoretical material (Muhtar et al., 2025; Widiastuti et al., 2024).The integration of mind mapping encouraged students to use artistic and innovative expressions in representing their understanding. Many groups used bright colors, creative symbols, and metaphoric visuals such as a *"tree of words"* to represent vocabulary growth, or *"building blocks"* to symbolize syntax formation.

Al-Inbari et al. (2023) said that the act of designing these visualizations cultivated both aesthetic and intellectual satisfaction. Students reported enjoying the freedom to express their understanding in personalized ways, contrasting with conventional note-taking or slide presentations. This finding aligns with Kiong et al. (2012)view that mind mapping enhances creative cognition through multisensory processing.

Lecturer observations supported this view. As one lecturer noted:

"The students were visibly more enthusiastic. They were not only learning about language development but also learning how to learn transforming theory into meaningful visual stories."

PBL naturally requires teamwork and shared responsibility(Hidayati &Tendrita, 2025). In the experimental group, collaboration extended beyond dividing tasks; it involved *co-constructing meaning*. Students debated the appropriate theoretical models, linked findings from readings, and integrated them into their collective mind maps. Such collaborative discourse deepened understanding, as students explained concepts to peers in their own words a form of social learning consistent with Vygotsky's (Wibowo et al., 2025) *zone of proximal development*. Through dialogue and scaffolding, students helped one another grasp difficult concepts, fostering mutual respect and interdependence. By the final meeting, teamwork had evolved into a positive classroom culture. Students confidently presented their projects, each contributing different perspectives. Their ability to discuss and defend ideas reflected both cognitive and communicative growth key learning outcomes (Jampel & Widiana , 2016) in teacher education.

The outcomes of this study align with and extend findings from previous research. For instance, Prachagool (2021) demonstrated that integrating visual mapping tools in science education significantly improved literacy and engagement. Similarly, Cetin (2020)confirmed that PBL enhances linguistic intelligence and writing ability when coupled with visual aids. However, the present study advances existing knowledge by situating this integration within **t**eacher education (Bron & Prudente, 2024), specifically focusing on *child language development* a field rarely examined in combination with PBL and mind mapping (Charusapsodsai & Intasena, 2024). The context of pre-service teachers provides a unique contribution because the participants are not only learners but future educators who will replicate such strategies in their classrooms.

Moreover, while prior studies often emphasize either cognitive or affective outcomes, this study bridges both dimensions, demonstrating that creative visualization and project-based inquiry jointly promote holistic learning. This resonates with Abdallah (2024), who found that mind mapping in flipped classrooms enhanced not only cognitive achievement but also practical skills and learner satisfaction.

Implications

The findings of this study offer several important implications for higher education, particularly within teacher education programs. First, integrating Project-Based Learning and mind mapping into course design aligns closely with the national *Merdeka Belajar* (Freedom to Learn) initiative, which promotes flexibility, contextual learning, and student-centered pedagogy. This integration encourages curriculum developers to include project-based modules that nurture creativity and critical thinking while maintaining relevance to real classroom practice. Furthermore, the approach highlights the need for continuous lecturer professional development, as

educators must be equipped to design PBL-oriented syllabi and to facilitate mind mapping sessions effectively. This pedagogical shift redefines lecturers not as information transmitters but as facilitators who guide students in co-constructing knowledge through inquiry and reflection. In terms of assessment, the findings suggest that traditional tests should be complemented with project-based evaluations and visual portfolios to capture a more holistic representation of student competence, including creativity and problem-solving skills.

Moreover, the combination of project work and visual mapping fosters a positive and enjoyable classroom culture in which learning becomes an engaging and meaningful process rather than a mechanical task, thereby enhancing intrinsic motivation. Finally, because the PBL–mind mapping model is adaptable across various disciplines, it offers scalability and the potential for broad pedagogical innovation beyond language development courses extending to areas such as educational psychology, curriculum studies, and literacy education making it a sustainable framework for promoting 21st-century competencies in teacher education.

Although this study yielded promising results, several limitations should be noted. The short duration of only three meetings limited the depth of learning and the ability to observe long-term retention. Future research could extend the intervention over a full semester to capture more sustained effects. Moreover, since this study focused mainly on cognitive outcomes, further investigations should explore other domains such as creativity, communication, critical thinking, and affective engagement using mixed-method or longitudinal designs. Finally, future work could examine the use of digital mind mapping tools to complement traditional projects, advancing hybrid pedagogies that balance technological and human interaction in post-pandemic education.

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of this article published in EPESS journal belongs to the authors.

Conflict of Interest

* The authors declare that there are no conflicts of interest related to the research, authorship, or publication of this article.

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