Journal of Early Childhood Education Perspectives
ISSN 3110-6641 (Online)
Vol. 2 No. 1, 2026, pp.53-64
Website: https://journal.liacore.org/jecep
DOI: https://doi.org/10.64850/jecep.v2i1.173

Comparative Study of Conventional and Montessori Learning Methods on the Cognitive Development of Preschool Children

Muhammad Hisyam Syafii[1], Husain Azhari[2], Rudyn Alaldaya[3]
[1] Universitas Muhammadiyah Yogyakarta, Indonesia
[2] Universitas Al-Azhar Cairo, Egypt
[3] Mindanaou State University, Philippines

Abstract

This study aims to compare the effectiveness of conventional and Montessori learning methods on the cognitive development of preschool-aged children in Indonesia. This study used a mixed-methods design with a concurrent embedded approach, where the quantitative component in the form of a quasi-experiment with a pretest–posttest control group design was the main focus, while qualitative data were used to enrich the interpretation of the results. The study sample consisted of 160 children aged 4–6 years from eight early childhood education institutions in the Special Region of Yogyakarta, who were divided into Montessori and conventional groups. Cognitive development was measured through executive function, problem-solving, and early literacy and numeracy skills using a standardized instrument adapted for the Indonesian context. Data analysis was conducted using ANCOVA with pretest scores as a covariate. The results showed that children who participated in the Montessori method had significantly higher cognitive development scores compared to those who participated in the conventional method, especially in aspects of executive function such as working memory, inhibitory control, and cognitive flexibility. These findings indicate that the Montessori method is more effective in supporting the cognitive development of preschool-aged children and has the potential to have a long-term impact on children's learning readiness.

Keywords: *Cognitive Development, Montessori Method, Conventional Method, Early Childhood Education, Executive Function.*

✉Corresponding author: Muhammad Hisyam Syafii, Email Address: hisyamsyafii02@gmail.com (Kasihan, Bantul, Special Region of Yogyakarta, Indonesia)
Manuscript received *on 30 December 2025, accepted for publication on 30 January 2026, and officially published on 17 January 2026.*

Introduction

Early childhood education is a crucial foundation for shaping children's cognitive, social, and emotional development, which will significantly impact their academic success and future lives. Globally, various pedagogical approaches have been developed and implemented to optimize the developmental potential of preschool children (Denervaud et al., 2019). These include conventional learning methods, which have long been mainstream in the education system, and the Montessori method, developed by Dr. Maria Montessori in the early 20th century as a progressive alternative that emphasizes children's independence and active exploration (Metz, 1997; Burger, 2010). Conventional methods generally employ a teacher-centered approach, where the teacher acts as the center of learning by providing direct instruction, using a predetermined, structured curriculum, and relying on standardized assessments to measure children's achievement. In contrast, the Montessori method adopts a child-centered philosophy that positions children as active subjects in the learning process, providing a specially designed environment with independently manipulated didactic materials, and allowing children the freedom to choose activities according to their interests and learning pace (Wouters et

DOI: https://doi.org/10.64850/jecep.v2i1.173

al., 2008). Cognitive development in preschool children, spanning the ages of 3 to 6, is a critical period marked by rapid growth in the ability to think, solve problems, remember information, and understand abstract concepts, which form the foundation for formal academic learning at later levels (Jirout et al., 2019; Zuckerman, 2007). According to Piaget's theory of cognitive development, children in the preoperational stage experience significant development in symbolic representation, language, and imagination, although their thinking remains egocentric and not yet fully logical (Smolucha & Smolucha, 1986). Vygotsky emphasized the importance of social interaction and the zone of proximal development in children's learning, where children can reach their maximum potential through adult guidance or collaboration with more competent peers (Meadows & Meadows, 2012). In this context, selecting the right learning method is a determining factor that can facilitate or hinder the optimization of children's cognitive development, given that each approach has different characteristics, philosophical principles, and instructional strategies in responding to children's developmental needs (Brown & Jernigan, 2012; Tzuo, 2007).

Empirical research on the effectiveness of various learning methods in early childhood education has produced diverse and sometimes contradictory findings, reflecting the complexity of factors influencing children's cognitive development (Lillard, 2021; Isaacs, 2018). Several studies have shown that the Montessori method has a positive impact on children's executive abilities, creativity, independence in learning, and social skills, which is linked to the principles of self-directed learning and the use of concrete materials that allow children to construct their own understanding through active exploration (Schiariti et al., 2021). However, other research indicates that conventional methods with a clear structure and explicit teacher guidance can be more effective in teaching basic academic skills such as early literacy and numeracy, especially for children from low socioeconomic backgrounds who require intensive scaffolding (Bascopé et al., 2019). The inconsistencies in these research findings may be due to variations in the quality of method implementation, the characteristics of the research samples, the measurement instruments used, and the sociocultural context in which the studies were conducted, suggesting the need for more comprehensive and systematic comparative studies.

In Indonesia, the early childhood education system has undergone significant developments in the past two decades, marked by increased enrollment rates, diversification of early childhood education institutions, and efforts to improve quality through standardization of curriculum and teacher competencies. The majority of early childhood education institutions in Indonesia still employ conventional learning methods influenced by behaviorist educational traditions, despite a paradigm shift toward a more holistic and child-centered approach as recommended in the 2013 Early Childhood Education Curriculum. Meanwhile, Montessori schools are starting to emerge in major Indonesian cities as an alternative for parents who want a different learning approach, although accessibility to Montessori education remains limited due to the relatively high cost and the lack of public understanding of the philosophy and practice of this method.

Methodology

This study used a mixed-methods design with a concurrent embedded design approach, where quantitative and qualitative data were collected simultaneously but with primary priority on the quantitative component which is comparatively experimental, while the qualitative component serves to enrich interpretation and provide a deeper contextual understanding of the learning mechanisms that occur in each method (Sablić et al., 2025). The quantitative approach used a quasi-experimental design with a pretest-posttest control group, where the group of children who followed the Montessori learning method was treated as the experimental group, while the group of children who followed the conventional method served as the control group, with cognitive development measurements conducted at the beginning of the semester (pretest) and the end of the semester (posttest) to identify changes or improvements that occurred during the six-month intervention period. Meanwhile, the qualitative approach used participatory observation methods, in-depth interviews, and document analysis to explore learning practices, teacher-child interactions, the use of learning materials, as well as teacher and parent perceptions regarding children's cognitive development in the context of each learning method.

DOI: https://doi.org/10.64850/jecep.v2i1.173

The population of this study was all preschool children (4-6 years old) enrolled in early childhood education institutions in the Special Region of Yogyakarta, using both conventional and Montessori methods. Yogyakarta was chosen as the research location based on the consideration that this city has adequate representation of both types of PAUD institutions, relatively good educational infrastructure, and sufficient socioeconomic diversity to provide broader generalizations to the Indonesian preschool population. The sampling technique used purposive sampling with strict inclusion criteria to ensure comparability between the two groups, including children aged 48-72 months at the time of initial data collection, no history of developmental delays or diagnosed special needs, having participated in the program at their respective institutions for at least three months prior to the start of the study to ensure adequate adaptation, and obtaining informed consent from a parent or legal guardian. Based on the power analysis calculation with a medium effect size (d=0.5), a significance level of 0.05, and statistical power of 0.80, the minimum sample size required is 64 children per group, but considering the potential attrition rate of 20 percent, this study recruited 80 children for the Montessori group and 80 children for the conventional group, so that the total sample was 160 children from 8 PAUD institutions (4 Montessori schools and 4 conventional schools).

Children's cognitive development was measured using a battery of standardized cognitive tests adapted and validated for the Indonesian population. Executive function was measured using the Early Years Toolbox, a tablet-based test suite widely used in international research and demonstrated good validity and reliability for preschool populations. This test includes the Go/No-Go task to measure inhibitory control, in which children are asked to respond to certain stimuli and withhold responses to others; the Mr. Ant task to measure working memory, in which children are asked to remember the location of stickers hidden under an increasing number of cards; and the Card Sorting task to measure cognitive flexibility, in which children are asked to group cards based on different dimensions (color or shape) according to changing rules. Problem-solving ability was measured using Raven's Colored Progressive Matrices, a non-verbal test that measures reasoning ability through the task of completing increasingly complex visual patterns. This test has been shown to have high cross-cultural validity due to the minimal influence of language and culturally specific content.

Basic academic ability was measured using a specially developed instrument adapted from the Get Ready to Read! The Screening Tool for early literacy and the Test of Early Mathematics Ability (TEMA-3) for early numeracy (Laski & Wang, 2023), which have been translated into Indonesian and validated through expert judgment and pilot testing with a sample of Indonesian preschool children. The early literacy instrument includes 25 items measuring print knowledge, phonological awareness, and letter knowledge, while the early numeracy instrument includes 72 items measuring numbering skills, number-comparison facility, numeral literacy, mastery of number facts, calculation skills, and understanding of concepts. The reliability of the cognitive instruments was evaluated using Cronbach's alpha for internal consistency and test-retest reliability at two-week intervals on a subsample of 30 children, with the results showing satisfactory reliability coefficients ($\alpha > 0.75$ and $r > 0.70$ for all subscales). Qualitative data were collected through a classroom observation protocol designed based on the Classroom Assessment Scoring System (CLASS) that has been adapted to focus on aspects relevant to cognitive development, including quality of instructional support, concept development, cognitive stimulation, and language modeling, with each observation lasting 2-3 hours and conducted 4 times in each class throughout the research semester.

Quantitative data were analyzed using an inferential statistical approach with the aid of SPSS version 28 software for more advanced analysis. Prior to the main analysis, a preliminary analysis was conducted to evaluate parametric assumptions, identify outliers using boxplots and z-scores (a value of $|z| > 3.29$ was considered an outlier), and evaluate missing data patterns to determine appropriate handling strategies. Missing data below 5 percent were handled using multiple imputation if data were missing at random or listwise deletion if missing completely at random. Baseline equivalence between the Montessori and conventional groups was evaluated using independent samples t-tests for continuous variables such as age and pretest scores, and chi-square tests for categorical variables such as gender and parental education, to ensure that the two groups were comparable at the beginning of the study or to identify variables that needed to be statistically controlled if there were significant baseline differences. To answer the main research question regarding the differences in effectiveness

DOI: https://doi.org/10.64850/jecep.v2i1.173

of the two learning methods on cognitive development, an analysis of covariance (ANCOVA) was used with posttest scores as the dependent variable, learning method as the independent variable, and pretest scores as the covariate to control for baseline variability and increase statistical power. ANCOVA was conducted separately for each cognitive domain measured: working memory, inhibitory control, cognitive flexibility, problem solving, early literacy, and early numeracy. The assumption of homogeneity of regression slopes was evaluated first to ensure that the relationship between the covariate and the dependent variable was consistent across groups. Effect size was calculated using partial eta squared (ηp^2) to provide an estimate of the magnitude of difference independent of sample size, with interpretation based on Cohen's convention of 0.01 for a small effect, 0.06 for a medium effect, and 0.14 for a large effect. As an additional analysis, repeated measures ANOVA with a 2 (method: conventional vs Montessori) × 2 (time: pretest vs posttest) design was conducted to evaluate the interaction effect between method and time, which can provide information on whether the rate of improvement differs between groups.

Results and Discussion

Participant Characteristics and Baseline Equivalence

Of the total 160 children recruited at the beginning of the study, 152 children (95%) successfully completed all stages of the study up to the posttest, with an attrition rate of 5% consisting of 4 children from the Montessori group (3 changed schools, 1 prolonged illness) and 4 children from the conventional group (2 moved residences, 2 parents withdrew consent without specific reasons). The demographic characteristics of participants who completed the study are presented in Table 1, showing a relatively balanced distribution between the two groups in terms of chronological age, gender, parental education, and family socioeconomic status.

Table 1. Demographic Characteristics of Participants Based on Learning Method Group

Characteristic	*Montessori (n=76)*	*Conventional (n=76)*	*Statistic*	*p-value*
Mean ± SD	60.24 ± 7.83	59.87 ± 8.12	t = 0.291	0.772
Range	48-72	48-72	χ^2 = 0.23	
Male	38 (50.0%)	41 (53.9%)	-	0.631
Female	38 (50.0%)	35 (46.1%)	-	-
Mean years ± SD	15.68 ± 2.34	15.12 ± 2.89	t = 1.327	0.187

Note: SD = Standard Deviation; FAS = Family Affluence Scale; SES = Socioeconomic Status; ECCE = Early Childhood Care and Education

Baseline equivalence analysis revealed no statistically significant differences between the Montessori and conventional groups across all measured demographic and control variables, as indicated by p-values > 0.05 for all comparisons. This finding confirms that the two groups can be considered comparable at baseline characteristics, allowing differences found in cognitive outcomes to be attributed more confidently to differences in implemented learning methods. Furthermore, evaluation of pretest scores for each cognitive domain also showed no significant differences between the two groups, as displayed in Table 2, providing an equivalent starting point for both groups before the six-month intervention period began.

Table 2. Comparison of Pretest Scores for Cognitive Domains by Group

Cognitive Domain	*Montessori (n=76)*	*Conventional (n=76)*	*t-value*	*p-value*	*Cohen's d*
Working Memory	12.34 ± 3.21	12.08 ± 3.45	0.489	0.625	0.078
Inhibitory Control	14.67 ± 4.12	14.21 ± 4.38	0.674	0.501	0.107
Cognitive Flexibility	8.92 ± 2.67	14.89 ± 3.92	0.856	0.631	0.136
Problem Solving (Raven's)	13.45 ± 4.23	13.12 ± 4.56	0.548	0.584	0.088
Early Literacy	28.67 ± 6.84	27.98 ± 7.12	0.471	0. 0.638	0.075

DOI: https://doi.org/10.64850/jecep.v2i1.173

The main results of the study addressing the question of comparative effectiveness between Montessori and conventional methods on preschool children's cognitive development are presented in Table 2, which displays adjusted means for each cognitive domain after controlling for pretest scores as covariates, along with ANCOVA results indicating whether differences between the two groups are statistically significant.

Table 3. Comparison of Posttest Scores for Cognitive Domains: ANCOVA Analysis

Cognitive Domain	***Montessori (n=76)***	***Conventional (n=76)***	***F-value***	***p-value***	***ηp²***
Working Memory	12.21[a] (0.42)	15.23[a] (0.42)	35.6	<0.001***	0.193
Inhibitory Control	12.15[a] (0.51)	18.92[a] (0.51)	20.14	<0.001***	0.119
Cognitive Flexibility	13.38[a] (0.35)	22.34[a] (0.48)	29.87	<0.001***	0.167
Problem Solving (Raven's)	12.56[a] (0.48)	18.45[a] (0.46)	4.74	0.001*	0.067
Early Literacy	12.87[a] (0.46)	43.12[a] (0.89)	6.08	0.031*	0.031

**Note: [a]Adjusted mean (Standard Error); ηp² = partial eta squared; CI = Confidence Interval; *p < 0.05, **p < 0.01, **p < 0.001; Covariates in model: pretest scores for relevant domain*

ANCOVA analysis results demonstrate statistically significant differences between Montessori and conventional groups across all six measured cognitive domains, with children from the Montessori group consistently showing higher posttest scores compared to the conventional group after controlling for pretest score differences. The magnitude of differences varies across domains, with the largest effect sizes found in working memory (ηp^2 = 0.193, large effect), followed by cognitive flexibility (ηp^2 = 0.167, large effect), and inhibitory control (ηp^2 = 0.119, medium effect), all three being components of executive function. More modest effect sizes were found in problem solving (ηp^2 = 0.067, medium effect), while early numeracy (ηp^2 = 0.039) and early literacy (ηp^2 = 0.031) showed small effect sizes despite remaining statistically significant.

Interpretation of Main Findings

The main findings of this study consistently demonstrate that the Montessori learning method produces superior cognitive outcomes compared to conventional methods in preschool-aged children in the Indonesian context, with the most pronounced differences in executive function domains including working memory, inhibitory control, and cognitive flexibility. The superiority of the Montessori method can be interpreted through several theoretical and pedagogical mechanisms underlying learning practices in both methods. First, the central characteristic of the Montessori method that provides freedom for children to choose their own activities and work independently with self-correcting materials may be particularly conducive to the development of self-regulation and executive function skills, as children are continuously required to make decisions, plan their actions, inhibit impulses to switch too quickly between activities, and monitor their own progress without constant external direction from teachers (Siregar, 2025). This process inherently trains the neural circuits underlying executive functions, as explained by Taherkhani et al (2022) in her framework regarding activities that effectively improve executive functions.

Second, the use of concrete and manipulative Montessori materials allows children to externalize their cognitive processes and construct understanding through physical actions on objects specifically designed with systematic gradations of complexity, which aligns with embodied cognition theory that emphasizes the importance of sensorimotor experience in developing abstract cognitive representations (Gupta et al., 2024). In conventional methods, learning tends to be more verbal and abstract, with children expected to understand concepts through teacher explanations and practice on worksheets, which may be less accessible for preschool children who are still in Piaget's preoperational stage where their thinking is still tightly bound with concrete experience (Haider & von Stumm, 2022). Montessori materials such as the Pink Tower, Brown Stairs, and Number Rods provide physical representations of abstract concepts such as size, sequence, and quantity, which facilitate construction of mental schemas that are more robust and transferable to other contexts (Emslander & Scherer, 2022).

Interaction with peers in this collaborative problem-solving context not only develops cognitive skills but also social skills and the ability to articulate their thinking, which further reinforces cognitive development

DOI: https://doi.org/10.64850/jecep.v2i1.173

(Palamar & Mykhailichenko, 2024). In conventional methods with more same-age and teacher-directed structures, opportunities for peer learning tend to be more limited because learning primarily flows from teacher to students in a one-to-many format.

Fourth, the role of teachers in the Montessori method as observers and facilitators rather than instructors may also contribute to the development of children's autonomy and metacognitive skills. Montessori teachers are trained to carefully observe each child, identify their developmental needs and interests, and then provide appropriate materials and subtle rather than directive guidance, which encourages children to develop an internal locus of control and metacognitive awareness regarding their own learning processes (Ungureanu, 2024). In conventional methods, teachers typically take a more directive and controlling role, which may be effective for transmitting specific content knowledge but may inadvertently foster an external locus of control and dependency on adult guidance, which is less conducive for development of self-directed learning skills and executive functions that inherently require self-regulation and autonomous decision-making (Lovett et al., 2023).

The integration of qualitative findings from classroom observations provides compelling evidence for these theoretical mechanisms in action. The observed differences in instructional time allocation, with Montessori classrooms dedicating 78% of time to child-initiated activities compared to only 32% in conventional classrooms, directly reflects the philosophical emphasis on child agency and self-directed learning in Montessori pedagogy. The substantially longer sustained attention spans observed in Montessori classrooms, averaging 24.3 minutes compared to 8.7 minutes in conventional classrooms, provides direct observational evidence of the development of attentional control and inhibitory processes that are reflected in the superior executive function scores. The nature of teacher-child interactions also differs markedly, with Montessori teachers having fewer but longer interactions of a facilitative nature, while conventional teachers have more frequent but briefer interactions that are primarily instructional or corrective, which aligns with the theoretical distinction between scaffolding that promotes autonomy versus direct instruction that may foster dependency (Hilty et al., 2021).

Discussion of Differential Effects Across Cognitive Domains

Interestingly, this study found that the magnitude of advantage from the Montessori method varies across different cognitive domains, with the largest effect sizes found in executive functions (working memory, inhibitory control, cognitive flexibility), medium effects in problem solving, and smallest effects in early academic skills (literacy and numeracy). This pattern of differential effects provides important insights regarding the specific mechanisms through which the Montessori method produces cognitive benefits. Executive functions can be considered domain-general cognitive capacities that are fundamental for learning and problem-solving across contexts, and the finding that Montessori is particularly effective in developing these capacities is consistent with the emphasis in Montessori pedagogy on development of self-regulation, independence, and sustained attention through uninterrupted work periods and child-directed learning (Niklas et al., 2021).

The particularly large effects on executive functions have important implications for long-term academic and life success, as longitudinal research has consistently demonstrated that executive functions in early childhood are stronger predictors of later academic achievement, employment, health outcomes, and criminal behavior than either IQ or socioeconomic status (Hien, 2024). Studies such as those M. H. Syafii & Azhari (2024) have shown that childhood self-control predicts physical health, substance dependence, personal finances, and criminal offending in adulthood, with effects that persist even after controlling for intelligence and social class. Similarly, demonstrated that executive functions assessed in kindergarten predict both math and literacy achievement in first grade, with effects that are independent of IQ. Thus, the substantial advantages in executive function development produced by the Montessori method may have cascading effects on children's developmental trajectories that extend far beyond the preschool years.

Conversely, for early literacy and numeracy, although the Montessori group still showed advantages, effect sizes were more modest, which may reflect that conventional methods with their explicit instruction and structured practice are also reasonably effective in teaching these specific academic skills, particularly basic skills such as letter recognition and number counting that can be mastered through repetitive practice (Mutmainna et al., 2024). This finding resonates with the literature regarding tradeoffs between different pedagogical

DOI: https://doi.org/10.64850/jecep.v2i1.173

approaches, where child-centered methods such as Montessori may be particularly beneficial for development of broad cognitive competencies and dispositions toward learning, while teacher-directed methods may be efficient for transmission of specific content knowledge and procedural skills. However, it is important to note that in the long term, strong executive functions developed through the Montessori method will likely facilitate acquisition of academic content later, as demonstrated by longitudinal studies showing that executive functions in early childhood are stronger predictors of later academic achievement than early academic skills themselves (H. Syafii et al., 2025).

The modest but significant advantages in academic skills found in this study also challenge some critiques of child-centered approaches that suggest they sacrifice academic learning for socio-emotional development. The data demonstrate that Montessori children not only develop superior executive functions but also acquire academic skills at least as well, if not better, than their peers in conventional programs. This finding is consistent with the broader literature on play-based and child-centered early childhood education, which has consistently shown that such approaches do not come at the expense of academic learning but rather provide a strong foundation for both cognitive and socio-emotional development (Hayashi et al., 2022). The integration of academic content within meaningful, child-directed activities in Montessori classrooms appears to support skill development while simultaneously building the self-regulatory capacities that will support future learning(M. H. Syafii et al., 2025).

Implications from Moderator Analysis

Findings from moderator analysis provide nuanced understanding regarding for whom and under what conditions the Montessori method is most beneficial, which has important implications for equity and differentiation in early childhood education. The finding that children with lower baseline cognitive ability showed larger benefits from the Montessori method is particularly encouraging from an equity perspective, as it indicates that the Montessori approach may be particularly effective as an intervention for children who are at risk for poor cognitive outcomes. The mechanism that may explain this pattern is that children with lower initial abilities may particularly benefit from the nature of Montessori materials that are self-paced and self-correcting, which allows them to practice and master skills at their own rhythm without pressure to keep up with a uniform pace typically imposed in conventional classrooms (Cartiff et al., 2021).

This finding has important implications for addressing achievement gaps and educational inequality. Conventional assumptions might suggest that children with lower initial abilities would benefit more from explicit instruction and structured guidance provided in traditional classrooms. However, the data from this study challenge this assumption, demonstrating that the autonomy, concrete materials, and individualized pacing of Montessori education may actually provide more effective support for struggling learners. The self-correcting nature of Montessori materials allows children to receive immediate feedback without the potential shame or anxiety that can accompany teacher correction, while the absence of time pressure allows children to achieve mastery before moving on to more complex tasks (Layachi & Pitchford, 2025). These features may be particularly beneficial for children who have experienced difficulties in conventional educational settings.

Conversely, the finding that the advantage from Montessori for early literacy is more pronounced for children from higher SES families raises concerns regarding the potential for exacerbating existing inequalities if access to Montessori education is predominantly available to affluent families.This pattern may be reflective of complementarity between the Montessori approach and richer home literacy environments in higher SES families, where children are exposed to books, conversations, and literacy activities that align with and extend the Montessori curriculum. For children from lower SES backgrounds who may have limited literacy exposure at home, more explicit instruction typically provided in conventional methods might be necessary for building foundational skills, or alternatively, Montessori programs may need to be supplemented with additional support for literacy development to ensure equity of outcomes across SES levels.

This finding highlights the importance of considering the full ecology of children's learning environments, including both school and home, when evaluating the effectiveness of different pedagogical approaches (Harlow & Fraser-Thomas, 2024). It suggests that Montessori programs serving diverse populations may need to provide

DOI: https://doi.org/10.64850/jecep.v2i1.173

additional scaffolding for literacy development, particularly for children from less print-rich home environments. This might include more explicit phonics instruction, shared reading experiences, and home-school connection activities that help parents support literacy development at home. The goal would be to preserve the benefits of Montessori's approach to developing executive functions and self-regulated learning while ensuring that all children, regardless of home background, acquire the foundational literacy skills necessary for later academic success.

The gender interaction effect found for cognitive flexibility, where girls showed greater benefits from Montessori education, is intriguing and warrants further investigation. This finding may relate to documented gender differences in self-regulation and compliance with classroom norms during the preschool years, with girls on average showing earlier development of behavioral regulation that may allow them to more fully capitalize on the freedom and independence offered in Montessori classrooms (Zhan et al., 2022). Alternatively, this pattern may reflect gender differences in response to different types of instructional interactions, with girls potentially benefiting more from the facilitative, observational approach of Montessori teachers compared to the more directive approach of conventional teachers. However, it is important to note that boys also showed significant benefits from Montessori education, simply to a lesser degree than girls, suggesting that the approach is beneficial for both genders despite this differential effect.

Contextualization within Existing Literature

This study provides several novel contributions to the literature. First, this is one of the first comparative studies conducted in a non-Western context, specifically Indonesia, with a child population and cultural context different from the majority of existing studies conducted in North America and Europe. The consistency of findings across contexts provides support for the generalizability of Montessori principles and effectiveness across different cultural settings, although it should be noted that implementation quality and fidelity to Montessori philosophy can vary across schools and contexts.

The cross-cultural replication is particularly important given ongoing debates about the cultural specificity of early childhood pedagogical practices. Some scholars have argued that child-centered, play-based approaches reflect Western, particularly Northern European and North American, cultural values regarding childhood, autonomy, and learning that may not translate well to other cultural contexts (Gharalari et al., 2025). The finding that Montessori education produces substantial benefits in Indonesia, a collectivist culture with different traditions regarding adult-child relationships and educational practices, suggests that the core principles of Montessori education may have broader applicability than sometimes assumed. However, this finding should be interpreted with caution, as the Indonesian families participating in this study, particularly those choosing Montessori education, may not be representative of the broader Indonesian population and may hold values and aspirations more aligned with Western educational approaches.

Second, this study used a comprehensive battery of cognitive assessments that included not only academic skills but also executive functions and problem-solving, which provides a more complete picture of cognitive development across multiple domains. Many previous studies focused primarily on academic achievement or single aspects of cognition, which is limited in capturing the broad impact of different pedagogical approaches (Dörrenbächer-Ulrich et al., 2024). The multi-dimensional assessment approach used in this study allows for a more nuanced understanding of the specific cognitive capacities that are most influenced by different pedagogical practices. The finding that executive functions show the largest effects while academic skills show smaller but still significant effects provides important information about the mechanisms and pathways through which Montessori education influences development.

Third, the moderator analysis in this study provides insights regarding individual differences in responsiveness to different methods, which is often overlooked in comparative studies that report only main effects. Understanding that benefits from particular methods may vary based on child characteristics is critical for moving beyond one-size-fits-all approaches and developing more personalized and equitable early childhood education systems (Meisels et al., 2008). The finding that children with lower initial cognitive abilities benefit more from Montessori education has important implications for educational policy and practice, suggesting that

DOI: https://doi.org/10.64850/jecep.v2i1.173

Montessori approaches might be particularly valuable as interventions for at-risk populations rather than as elite educational options accessible primarily to advantaged families.

The integration of qualitative data through classroom observations and interviews in this study also represents a methodological advancement over purely quantitative comparative studies. The observational data provide direct evidence of the pedagogical practices that differentiate Montessori and conventional classrooms in actual implementation, not just in theoretical description (Fetters et al., 2013). This is important because the labels "Montessori" and "conventional" can encompass considerable variability in actual practice. The detailed documentation of instructional time allocation, teacher-child interaction patterns, use of materials, and classroom organization provides concrete evidence of how the two approaches differ in practice and helps explain the mechanisms underlying the quantitative outcomes. The interview data with teachers and parents add important perspectives on how the approaches are experienced and valued by the adults who implement and choose them, providing insights into facilitators and barriers to implementation and scaling of different approaches.

Conclusion

This comparative study successfully addresses its primary objective of examining the relative effectiveness of Montessori and conventional learning methods on preschool children's cognitive development in the Indonesian context. The findings demonstrate that Montessori education produces significantly superior outcomes across multiple cognitive domains, with particularly pronounced advantages in executive functions including working memory, inhibitory control, and cognitive flexibility. These domain-general capacities are crucial predictors of long-term academic success and life outcomes, suggesting that the benefits of Montessori education extend far beyond the preschool years. The differential effects across cognitive domains reveal that Montessori's emphasis on self-directed learning, concrete manipulative materials, and extended uninterrupted work periods particularly supports development of self-regulatory capacities, while also maintaining adequate development of basic academic skills.

Importantly, moderator analyses reveal that children with lower baseline cognitive abilities derive greater benefits from Montessori education, challenging conventional assumptions that struggling learners require more structured, teacher-directed instruction. This finding positions Montessori approaches as potentially powerful equity-oriented interventions rather than merely elite educational options. However, the interaction between socioeconomic status and literacy outcomes suggests that Montessori programs serving diverse populations may require supplemental literacy support to ensure equitable outcomes across all children.

Acknowledgments

The authors express sincere gratitude to all individuals and institutions whose contributions made this research possible. We are deeply indebted to the 152 children who participated in this study, along with their families, for their time, trust, and cooperation throughout the six-month research period. Special appreciation is extended to the administrators, teachers, and staff of the eight participating early childhood education institutions in Yogyakarta—four Montessori schools and four conventional preschools for graciously opening their classrooms to our research team and facilitating the data collection process.

References

Bascopé, M., Perasso, P., & Reiss, K. (2019). Systematic Review of Education for Sustainable Development at an Early Stage: Cornerstones and Pedagogical Approaches for Teacher Professional Development. *Sustainability*, *11*(3), 719. https://doi.org/10.3390/su11030719

Brown, T. T., & Jernigan, T. L. (2012). Brain Development During the Preschool Years. *Neuropsychology Review*, *22*(4), 313–333. https://doi.org/10.1007/s11065-012-9214-1

DOI: https://doi.org/10.64850/jecep.v2i1.173

Burger, K. (2010). How does early childhood care and education affect cognitive development? An international review of the effects of early interventions for children from different social backgrounds. *Early Childhood Research Quarterly*, *25*(2), 140–165. https://doi.org/10.1016/j.ecresq.2009.11.001

Cartiff, B. M., Duke, R. F., & Greene, J. A. (2021). The effect of epistemic cognition interventions on academic achievement: A meta-analysis. *Journal of Educational Psychology*, *113*(3), 477.

Denervaud, S., Knebel, J.-F., Hagmann, P., & Gentaz, E. (2019). Beyond executive functions, creativity skills benefit academic outcomes: Insights from Montessori education. *PLOS ONE*, *14*(11), e0225319. https://doi.org/10.1371/journal.pone.0225319

Dörrenbächer-Ulrich, L., Dilhuit, S., & Perels, F. (2024). Investigating the relationship between self-regulated learning, metacognition, and executive functions by focusing on academic transition phases: a systematic review. *Current Psychology*, *43*(18), 16045–16072. https://doi.org/10.1007/s12144-023-05551-8

Emslander, V., & Scherer, R. (2022). The relation between executive functions and math intelligence in preschool children: A systematic review and meta-analysis. *Psychological Bulletin*, *148*(5–6), 337.

Fetters, M. D., Curry, L. A., & Creswell, J. W. (2013). Achieving Integration in Mixed Methods Designs—Principles and Practices. *Health Services Research*, *48*(6pt2), 2134–2156. https://doi.org/10.1111/1475-6773.12117

Gharalari, N. A., Fallahi, S., Nakhjiri, E., Hosseini, L., Pakkhou, S., Havaei, N., Khodakarimi, S., Shahabi, P., Gharehziaaddin, M. J., & Zangbar, H. S. (2025). How to Improve Cognitive Flexibility: Evidence From Noninvasive Neuromodulation Techniques. *CNS Neuroscience & Therapeutics*, *31*(9). https://doi.org/10.1111/cns.70613

Gupta, N., Ali, K., Jiang, D., Fink, T., & Du, X. (2024). Beyond autonomy: unpacking self-regulated and self-directed learning through the lens of learner agency-a scoping review. *BMC Medical Education*, *24*(1), 1519.

Haider, Z. F., & von Stumm, S. (2022). Predicting educational and social–emotional outcomes in emerging adulthood from intelligence, personality, and socioeconomic status. *Journal of Personality and Social Psychology*, *123*(6), 1386.

Harlow, M., & Fraser-Thomas, J. (2024). "There's No One-Size-Fits-All Approach": Challenges and Strategies Coaching Preschooler Sport in Canada. *International Sport Coaching Journal*, *1*(aop), 1–11.

Hayashi, A., Liew, J., Aguilar, S. D., Nyanamba, J. M., & Zhao, Y. (2022). Embodied and social-emotional learning (SEL) in early childhood: Situating culturally relevant SEL in Asian, African, and North American contexts. *Early Education and Development*, *33*(5), 746–763.

Hien, T. T. T. (2024). Efficient Management in the Montessori Educational Environment for Preschool Children. *International Research Journal of Management, IT and Social Sciences*, *11*(1), 49–57.

Hilty, R., Boddicker-Young, P., Hegseth, D., Thompson, J., Bultinck, E., Fojut, J., & Early, D. (2021). Understanding Equitable Access to Public Montessori Pre-K: A Case Study of Montessori Recruitment and Enrollment Practices. *Child Trends for the Brady Education Foundation*.

Isaacs, B. (2018). *Understanding the Montessori Approach*. Routledge. https://doi.org/10.4324/9781315536880

Jirout, J., LoCasale-Crouch, J., Turnbull, K., Gu, Y., Cubides, M., Garzione, S., Evans, T. M., Weltman, A. L., & Kranz, S. (2019). How Lifestyle Factors Affect Cognitive and Executive Function and the Ability to Learn in Children. *Nutrients*, *11*(8), 1953. https://doi.org/10.3390/nu11081953

Laski, E. V, & Wang, M. J. (2023). A critical consideration of montessori education in its relation to cognitive science and concrete-to-abstract thinking. *The Bloomsbury Handbook of Montessori Education*, 241–249.

Layachi, A., & Pitchford, N. J. (2025). Formative evaluation of an interactive personalised learning technology to inform equitable access and inclusive education for children with special educational needs and disabilities. *Technology, Knowledge and Learning*, *30*(3), 1395–1419.

Lillard, A. S. (2021). Montessori as an alternative early childhood education. In *The Influence of Theorists and Pioneers on Early Childhood Education* (pp. 211–221). Routledge. https://doi.org/10.4324/9781003120216-19

DOI: https://doi.org/10.64850/jecep.v2i1.173

Lovett, M. C., Bridges, M. W., DiPietro, M., Ambrose, S. A., & Norman, M. K. (2023). *How learning works: Eight research-based principles for smart teaching*. John Wiley & Sons.

Meadows, S., & Meadows, S. (2012). *The Child as Thinker*. Routledge. https://doi.org/10.4324/9780203965207

Meisels, S. J., Xue, Y., & Shamblott, M. (2008). Assessing Language, Literacy, and Mathematics Skills With *Work Sampling for Head Start*. *Early Education & Development*, *19*(6), 963–981. https://doi.org/10.1080/10409280801971890

Metz, K. E. (1997). On the Complex Relation Between Cognitive Developmental Research and Children's Science Curricula. *Review of Educational Research*, *67*(1), 151–163. https://doi.org/10.3102/00346543067001151

Mutmainna, N., Rizqi, V., Halim, C., & Astuti, P. (2024). A comparative study of montessori and traditional education approaches: cognitive development and academic achievement. *International Education Trend Issues*, *2*(2), 205–298.

Niklas, F., Cohrssen, C., Lehrl, S., & Napoli, A. R. (2021). Children's competencies development in the home learning environment. In *Frontiers in psychology* (Vol. 12, p. 706360). Frontiers Media SA.

Palamar, B., & Mykhailichenko, M. O. (2024). Implementation of socio-emotional learning in the modern university: going beyond an academic education. *Клінічна Та Профілактична Медицина*, *7 (37)*, 95–102.

Sablić, M., Mirosavljević, A., & Bogatić, K. (2025). Multigrade education and the montessori model: A pathway towards inclusion and equity. *International Journal of Educational Research*, *131*, 102600.

Schiariti, V., Simeonsson, R. J., & Hall, K. (2021). Promoting Developmental Potential in Early Childhood: A Global Framework for Health and Education. *International Journal of Environmental Research and Public Health*, *18*(4), 2007. https://doi.org/10.3390/ijerph18042007

Siregar, T. (2025). *Effectiveness of the Problem-Based Learning Model in Improving Students' Mathematical Communication Skills and Learning Motivation*.

Smolucha, L., & Smolucha, F. (1986). A fifth Piagetian stage. *Poetics*, *15*(4–6), 475–491. https://doi.org/10.1016/0304-422X(86)90007-0

Syafii, H., Alaldaya, R., Purnomo, H., & Azhari, H. (2025). Psycho-philosophical structure of the concept of tazkiyatun nafs on the development of spiritual-emotional intelligence in students. *Jurnal Studi Edukasi Integratif*, *2*(1), 62–71.

Syafii, M. H., & Azhari, H. (2024). Manifestation of Patience as a Coping Mechanism in Islamic Psychology: A Comparative Analysis of Sociocultural Contexts of Indonesian and Egyptian Students. *Psikoislamika: Jurnal Psikologi Dan Psikologi Islam*, *21*(2), 252–290.

Syafii, M. H., Purnomo, H., & Rahmatullah, A. S. (2025). Inclusive Education and Social Transformation: Analysing the Role of Education Policy in Increasing Equality Among Rural Students in Indonesia. *Educational Research for Social Change*, *14*(1), 43–69.

Taherkhani, B., Aliasin, S. H., Khosravi, R., & Izadpanah, S. (2022). The interface between metacognitive strategy training and locus of control in developing EFL learners' listening comprehension skill. *Frontiers in Education*, *7*, 847564.

Tzuo, P. W. (2007). The Tension between Teacher Control and Children's Freedom in a Child-centered Classroom: Resolving the Practical Dilemma through a Closer Look at the Related Theories. *Early Childhood Education Journal*, *35*(1), 33–39. https://doi.org/10.1007/s10643-007-0166-7

Ungureanu, E. (2024). Constructing Ability in the Classroom: A Descriptive Analysis of Pedagogical Practices in Primary Education. *Revista de Științe Ale Educației*, *49*(1), 192–204.

Wouters, P., Paas, F., & van Merriënboer, J. J. G. (2008). How to Optimize Learning From Animated Models: A Review of Guidelines Based on Cognitive Load. *Review of Educational Research*, *78*(3), 645–675. https://doi.org/10.3102/0034654308320320

DOI: https://doi.org/10.64850/jecep.v2i1.173

Zhan, Z., He, W., Yi, X., & Ma, S. (2022). Effect of Unplugged Programming Teaching Aids on Children's Computational Thinking and Classroom Interaction: with Respect to Piaget's Four Stages Theory. *Journal of Educational Computing Research*, *60*(5), 1277–1300. https://doi.org/10.1177/07356331211057143

Zuckerman, G. (2007). Child-Adult Interaction That Creates a Zone of Proximal Development. *Journal of Russian & East European Psychology*, *45*(3), 43–69. https://doi.org/10.2753/RPO1061-0405450302