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Implementation of the Montessori Method in Early Childhood Education: A Case Study on Early Childhood Education Institutions Applying the Montessori Method

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ABSTRACT

Backround: The Montessori method offers an innovative approach to early childhood education, but its implementation in Indonesia faces various challenges.
Objective: This study examines the effectiveness and implementation of the Montessori method in Indonesian PAUD institutions using a mixed-method approach with a sequential explanatory design. The research was carried out in 5 Montessori PAUD institutions in Jakarta, Bandung, and Yogyakarta (January-June 2024).
Method: The quantitative component involved 120 children aged 3-6 years with pre-test and post-test using ASQ-3, Child Development Inventory, Montessori Assessment Checklist, SSRS, and DESSA-mini, analyzed by paired sample t-test and ANOVA. The qualitative component included structured observation (600 hours), in-depth interviews with 25 teachers and 5 principals, and focus group discussions with 100 parents, analyzed using thematic analysis.
Findings and Implications: Quantitative results showed a significant increase ($p<0.001$): independence 42.7% (Cohen's $d=1.87$), cognitive 38.5%, and social-emotional 44.3%. The quality of the prepared environment is strongly correlated with developmental outcomes ($r=0.78$). The qualitative analysis identified five themes: prepared environment as a foundation, transformation of the role of teachers into observer-facilitators (68% of the time for observation), practical life activities as the key to independence, mixed-age grouping facilitating peer learning, and implementation challenges including the scarcity of trained teachers (68%), high material costs (76%), and parental misconceptions (58%).
Conclusion: The Montessori method is effective in optimizing the holistic development of children when implemented with high fidelity. Government policies are needed for certification recognition, material subsidies, development of local production, and systematic parent education to expand access to quality Montessori education.

INTRODUCTION

Early childhood education (*Pendidikan Anak Usia Dini*/PAUD) is a strategic investment in the development of quality human resources. In the age range of 0-6 years, children experience a golden age in which brain growth and

development take place very rapidly, reaching 80% of adult brain capacity (Hyde et al., 2022). This critical period determines the foundation for all aspects of children's cognitive, motor, language, social-emotional, moral-spiritual, and artistic development that will affect their quality of life until adulthood (Lundborg et al., 2025). Neuroscience research proves that proper stimulation at an early age forms a strong brain architecture, increases learning capacity, and builds positive character that lasts a lifetime (Suraya et al., 2024). Therefore, the selection of learning methods that are in accordance with the characteristics and needs of children's development is a determining factor in the success of early childhood education.

Indonesia has shown a commitment to the development of early childhood education through various national policies and programs. Data from the Ministry of Education, Culture, Research, and Technology in 2023 recorded that the gross participation rate (APK) of PAUD reached 72.49%, a significant increase from 56.3% in 2015 (Herdiyanti & Suparno, 2023). The government has allocated a substantial budget for the development of early childhood education infrastructure, teacher training, and the provision of operational assistance. However, this quantitative expansion faces serious challenges in the quality dimension. An evaluation by the National Education Standards Agency shows that the majority of PAUD institutions still apply conventional learning that is teacher-centered and academic-oriented (Jannah & Setiawan, 2022). Children are forced to master *calistung* skills (reading, writing, and arithmetic) at an early age without considering developmental readiness, while fundamental aspects such as independence, creativity, social skills, and life skills are neglected (Rizky Iddha Purnaningtyas & Sukartono, 2024).

The problems of early childhood learning in Indonesia are multidimensional and systemic. First, the dominance of behavioristic paradigms that emphasize drill and practice, memorization, and stimulus-response conditioning ignores the active knowledge construct by children (Monica & Yaswinda, 2021). Second, uniform and rigid learning does not accommodate the diversity of learning styles, developmental speeds, and individual interests of children (Monica & Yaswinda, 2021). Third, learning environments that are not purposively designed fail to provide space for self-paced exploration, experimentation, and discovery (Sanchez, 2025).

Fourth, the dominant role of teachers as the only source of knowledge limits children's initiative, curiosity, and independence. Fifth, the orientation on the final product rather than the learning process reduces the learning experience to just the achievement of short-term academic targets (Ceccato et al., 2025). This creates a paradox: on the one hand, early childhood participation increases, but on the other hand, the quality of the learning experience is not optimal in preparing children for the challenges of the 21st century that require critical thinking, creativity, collaboration, and adaptability (Al Akromi, 2024).

The gap between early childhood learning practices and child development principles encourages the exploration of alternative methods that are more humanistic and developmentally appropriate. The Montessori method, developed by Dr. Maria Montessori (1870-1952) based on decades of scientific observation of children, offers a revolutionary paradigm that places the child as an active subject in the learning process (Anisaturrizqi et al., 2025). The Montessori philosophy is based on three fundamental principles: (1) each child has a unique potential and intrinsic motivation to learn (absorbent mind); (2) the child's development takes place through sensitive periods that must be appreciated and facilitated; (3) freedom within clear rules allows children to develop self-discipline, responsibility, and independence .

This method operationalizes this philosophy through five implementing pillars: prepared environment (structured environment that encourages self-exploration), didactic materials (self-correcting learning tools that concretize abstract concepts), teachers as facilitators and observers (not instructors), mixed-age grouping (cross-age collaborative learning), and uninterrupted work cycles (continuous work periods without interruption)he effectiveness of the Montessori method has been validated through extensive empirical research in various countries. A longitudinal study of Anisaturrizqi(2025) involving 112 children in Milwaukee showed that Montessori program graduates excelled significantly in academic ability (reading, math), executive function (self-control, planning), and social skills (empathy, conflict resolution) compared to the control group.

Research by Rathunde and Csikszentmihalyi (2005) found that Montessori students have a higher level of intrinsic motivation, flow experience, and orientation to the learning process. A meta-analysis of Marshall (2017) of 32 studies showed a moderate to large effect size on cognitive (d=0.57), academic (d=0.65), and social-emotional (d=0.51) development. Neuroimaging studies confirm that the Montessori environment optimizes the formation of neural connections in the prefrontal cortex related to executive function and self-regulation. This scientific evidence positions Montessori not just as a pedagogical trend, but as an evidence-based learning system that is consistent with the principles of developmental neuroscience and contemporary cognitive psychology.

In Indonesia, the adoption of the Montessori method has experienced exponential growth in the last decade. The Indonesian Montessori Association notes that more than 500 PAUD institutions that identify themselves as "Montessori-based" or "Montessori-inspired", spread across Jakarta, Bandung, Surabaya, Yogyakarta, Bali, and other major cities (Asosiasi Montessori Indonesia, 2022). This phenomenon is driven by the awareness of urban middle-class parents of the importance of quality education, access to global information on best practices in children's education, and disillusionment with conventional

systems that are considered to kill children's potential (Xu & Spruyt, 2025). However, the implementation of Montessori in Indonesia faces its own complexities. An exploratory survey conducted by researchers at 30 "Montessori" institutions in Greater Jakarta revealed extreme variations in the fidelity of implementation: only 23% met the international standards of the Association Montessori Internationale (AMI) or the American Montessori Society (AMS), while 47% made substantial adaptations, and the remaining 30% only adopted the "Montessori" label without significant pedagogical transformation (Han, 2025).

The main challenges include: (1) the scarcity of international Montessori certified teachers due to training costs that reach 50-150 million rupiah; (2) high investment for authentic Montessori tools that are mostly imported; (3) the understanding gap between the Montessori philosophy that emphasizes freedom and the expectation of strong control in Indonesian educational culture; (4) the absence of national standards and quality assurance mechanisms for the Montessori program; (5) difficulties in integrating the Montessori curriculum with the Independent Curriculum set by the government (Chang et al., 2025; Johnson et al., 2025). A significant knowledge gap still lies in the Indonesian educational literature regarding the implementation of Montessori.

The majority of existing publications are descriptive-normative in nature that explain the theoretical principles of Montessori without an in-depth analysis of how this method is adapted, the obstacles to real implementation, and its effectiveness in the socio-cultural context of Indonesia (Nijma & Machali, 2025). Empirical studies of learning outcomes, comparisons with other methods, or best practices in Montessori contextualization are still very limited. In fact, a comprehensive understanding of the dynamics of implementation, not only theoretical idealism, is a prerequisite for scaling up sustainable educational innovation (Hofstad et al., 2026; Lemmetty, 2025). Cultural contextualization is also crucial considering that the values of collectivism, social hierarchy, and orientation to group harmony in Indonesian culture can be in tension with Montessori's emphasis on individualism and children's autonomy.

This article aims to fill this gap through a comprehensive study of the implementation of the Montessori method in the context of Indonesian PAUD. Specifically, the objectives of the research include: (1) elaborating the philosophical and operational principles of the Montessori method and its theoretical-empirical foundations; (2) analyze Montessori implementation practices in Indonesian PAUD institutions, including model variations, adaptation strategies, and fidelity levels; (3) evaluate the effectiveness of the Montessori method in developing independence, concentration, creativity, problem-solving skills, and holistic developmental aspects of children aged 3-6 years; (4) identify facilitative and inhibitive factors in implementation, including teacher competence, availability of resources, parental support, and cultural

appropriateness; (5) formulate contextual adaptation models and policy recommendations for optimizing quality, affordable, and sustainable Montessori implementation in the Indonesian PAUD ecosystem.

This study makes a significant contribution on three levels. Theoretically, this article enriches the academic discourse on alternative pedagogy in early childhood education with an Indonesian contextual perspective, complementing the global literature dominated by research from Western countries. Practically, the findings and recommendations can be a guide for education practitioners, teachers, principals, foundation managers in designing, implementing, and developing authentic yet adaptive Montessori programs. For parents, this study provides evidence-based information to make informed decisions about their child's educational choices.

Policy-wise, analysis of systemic challenges and strategic solutions can inform education regulators in formulating quality standards, accreditation systems, subsidy schemes, and capacity building programs to expand access to quality Montessori education without compromising the fundamental principles of the method. In the end, this study contributes to the collective effort to create an Indonesian PAUD ecosystem that is not only accessible and affordable, but especially transformative in optimizing the potential of each child as independent learners, critical thinkers, and individuals with character.

RESEARCH METHOD

This study used a mixed-method approach with an exploratory case study design that integrated quantitative and qualitative data to produce a comprehensive understanding of the implementation of the Montessori method in Indonesia. The selection of mixed-methods was based on the complexity of the phenomenon being studied, where aspects such as learning effectiveness, implementation dynamics, and contextual challenges required methodological triangulation for optimal validity of findings. Sequential explanatory design was applied, where quantitative data collection and analysis were carried out first to measure learning outcomes, followed by in-depth qualitative exploration to understand the mechanisms, contexts, and nuances of implementation that could not be captured through quantitative measurement alone.

The research was carried out in 5 *PAUD* institutions that applied the Montessori method located in Jakarta (2 institutions), Bandung (2 institutions), and Yogyakarta (1 institution) during the period from January to June 2024. The selection of these three cities was based on the consideration that these cities were the centers of concentration of Montessori institutions in Indonesia with a variety of demographic, socio-economic, and cultural characteristics that were representative of the Indonesian urban context. The duration of the study of 6 months was chosen to provide sufficient time for significant and feasible child development observation within the limitations of research resources.

Population and Sample

Institutional Inclusion Criteria

Early childhood education institutions that were the research loci were selected using purposive sampling techniques with specific criteria: (1) had operated a Montessori program for at least 3 years to ensure the maturity of implementation; (2) had a minimum of 60% of teachers who had completed Montessori certification from a recognized training institution; (3) provided a complete set of Montessori materials that covered a minimum of 80% of the standard materials for the preschool level; (4) implemented an uninterrupted work cycle of at least 2.5 hours according to Montessori standards; (5) were willing to participate in all stages of research including intensive observation and longitudinal data collection.

Research Participants

Students

120 children aged 3-6 years (mean age = 4.7 years, SD = 0.9) who had participated in the Montessori program for at least 3 months. Age distribution: 3-4 years (n=38, 31.7%), 4-5 years (n=45, 37.5%), 5-6 years (n=37, 30.8%). Gender ratio: 58 males (48.3%), 62 females (51.7%).

Teachers

25 certified Montessori teachers with an average teaching experience of 6.2 years (range 2-15 years). Qualifications: 16 teachers (64%) had an AMI (Association Montessori Internationale) certificate, 9 teachers (36%) had an AMS (American Montessori Society) certificate or an accredited local training center certificate.

Parents

100 parents (response rate 83.3% of a total of 120 families) who were willing to participate in surveys, interviews, and documentation of child development at home.

Quantitative Research Instruments:

Ages and Stages Questionnaire, Third Edition (ASQ-3)

A standardized and validated child development screening instrument for the ages of 0-66 months, measuring five developmental domains, namely communication, gross motor, fine motor, problem-solving, and personal-social skills. The reliability of the instrument was demonstrated by Cronbach's alpha of 0.85-0.91 across domains.

Child Development Inventory (CDI)

A comprehensive instrument to assess the development of children aged 15 months-6 years included eight scales: social, self-help, gross motor, fine motor, expressive language, language comprehension, letters, and numbers. The validity of the construct had been proven by a high correlation (r=0.72-0.89) with clinical assessments.

Montessori Assessment Checklist

A structured observation instrument developed based on Montessori developmental milestones, measuring 45 developmental indicators specific to the Montessori curriculum including practical life skills, sensorial discrimination, mathematical understanding, language development, and cultural awareness. The instrument had been validated through expert judgment by 3 Montessori AMI trainers and pilot tested with inter-rater reliability κ=0.83.

Social Skills Rating System (SSRS)

An instrument to measure children's social competence included cooperation, assertion, responsibility, empathy, and self-control. The teacher rating and parent rating versions were used for data triangulation. Internal reliability α=0.87-0.94.

Devereux Student Strengths Assessment (DESSA-mini)

A brief screening instrument to measure children's social-emotional competencies including self-awareness, self-management, social awareness, relationship skills, and responsible decision-making. Instrument sensitivity and specificity >80%.

Qualitative Instruments:

Structured Observation Guide

A systematic classroom observation protocol included the dimensions of prepared environment (layout, materials organization, aesthetics), teacher behaviors (instruction type, interaction patterns, intervention frequency), child engagement (concentration duration, material choice, social interactions), and classroom climate (noise level, movement freedom, behavioral expectations).

Semi-structured Interview Guide

Teachers were given 25 open-ended questions that explored their understanding of educational philosophy, challenges in classroom implementation, teaching strategies used, utilization of learning materials, assessment approaches to student development, and collaboration with parents in supporting children's learning process.

Parents were given 20 questions that explored their reasons and rationale for choosing a particular school or educational approach, their expectations, changes they observed in their child's development, alignment between home and school education, and their level of satisfaction with the educational services provided.

The principal was given 30 questions covering the school's vision and mission, curriculum design and development, teacher training and development programs, educational quality assurance systems, stakeholder relationship management, and sustainability strategies to ensure the school could continue to develop and provide quality education in the long term.

Data Collection Procedure

Preparation Phase (December 2023)

The research began with obtaining formal licensing from the *PAUD* institution and securing informed consent from parents. Ethical clearance was granted by the University Research Ethics Committee (No: 2024/KEP/001). Three research assistants were trained to ensure standardization of observations and interviews. To ensure validity and reliability, the instrument underwent pilot testing with 15 children in one non-sample institution.

Baseline Assessment Phase (January 2024, Weeks 1-2)

Pre-tests using ASQ-3 and CDI were conducted by trained assessors in individual settings for 120 children, with each assessment lasting 30-45 minutes per child. The baseline Montessori Assessment Checklist was implemented through structured observations over two weeks, totaling 40 hours of observation per institution. An initial parent survey was also administered to gather information on children's current development and family demographics.

Longitudinal Observation Phase (January-June 2024)

Weekly classroom observations were conducted for 24 weeks, with each visit lasting 3 hours using time-sampling and event-sampling techniques. Bi-weekly documentation included children's work products and progress photographs. Teachers maintained monthly journals to record significant milestones, challenges, and reflections. Throughout this phase, continuous monitoring tracked attendance, participation patterns, and any contextual changes that might affect the study.

In-Depth Interview Phase (March-April 2024)

Semi-structured interviews were conducted with 25 teachers, each lasting 60-90 minutes and audio-recorded with consent. Five focus group discussions were organized with parents, with 15-20 parents per group and sessions lasting 90 minutes. In-depth interviews with 5 principals were carried out, each lasting 90-120 minutes. Member checking was performed to validate preliminary findings and ensure accuracy of interpretations.

Post-test Assessment Phase (June 2024, Weeks 3-4)

The post-test utilized the same instruments as the pre-test to measure developmental changes over the study period. Final Montessori Assessment Checklist observations were completed, and parent satisfaction surveys along with evaluation questionnaires were distributed. The phase concluded with the collection of institutional documents, including curriculum plans, assessment records, and parent communications, to provide comprehensive context for the findings.

Data Analysis

Quantitative Data Analysis

Quantitative data were analyzed using SPSS version 26.0 with the following steps:

1. Data Cleaning and Screening: Checking for missing data (handled using multiple imputation), outlier detection (using z-scores >3.29), and normality testing (Shapiro-Wilk test).
2. Descriptive Statistics: Calculation of means, standard deviations, frequencies, and percentages for demographic variables and outcome measures.
3. Paired Sample t-tests: To compare pre-test and post-test scores in each developmental domain, with significance level $\alpha=0.05$. Effect sizes were calculated using Cohen's *d* with interpretations: 0.2 (small), 0.5 (medium), 0.8 (large).

4. One-way ANOVA: To examine differences in developmental outcomes across age groups (3-4, 4-5, 5-6 years) and institutions, followed by post-hoc Tukey's HSD tests when significant differences were found.
5. Correlation Analysis: Pearson correlation for examining relationships between different developmental domains and between environmental quality and child outcomes.
6. Reliability Testing: Internal consistency of instruments verified using Cronbach's alpha, inter-rater reliability for observational measures calculated using Cohen's kappa.

Qualitative Data Analysis

Qualitative data from interviews, observations, and documents were analyzed using thematic analysis following the framework of Braun and Clarke (2006):

1. Familiarization: Verbatim transcription of interviews, repeated reading of transcripts and field notes for immersion in data.
2. Initial Coding: Systematic coding of data segments using NVivo 12 software, with codes emerging inductively from the data and deductively from the theoretical framework.
3. Theme Development: Grouping related codes into broader themes and sub-themes, creating thematic maps for visualizing relationships.
4. Review and Refinement: Iterative process of reviewing themes against coded data and entire dataset, refining theme definitions and boundaries.
5. Defining and Naming: Clear definitions for each theme with illustrative quotes, ensuring themes were coherent, distinct, and directly addressing research questions.
6. Integration: Triangulation of quantitative findings with qualitative themes for comprehensive interpretation, identifying convergences, divergences, and complementarities.

Validity and Reliability

Validity

1. Internal validity: Controlled for confounding variables through careful sampling, standardized protocols, and multiple time points measurement.
2. Construct validity: Using validated instruments with established psychometric properties.
3. Triangulation: Multiple data sources (children, teachers, parents), methods (observation, interviews, testing), and investigators (team coding).
4. Member checking: Preliminary findings were shared with participants for verification and feedback.

Reliability

1. Inter-rater reliability: Two observers independently coded 20% of observational data, achieving Cohen's $\kappa=0.83$.
2. Test-retest reliability: Subset of 20 children reassessed in 2-week intervals, showing correlation $r=0.88$.
3. Internal consistency: All instruments demonstrated Cronbach's $\alpha > 0.80$.

4. Audit trail: Comprehensive documentation of all research decisions, data collection procedures, and analytical processes.

Ethical Considerations

This research obtained ethical clearance from the University Research Ethics Committee with registration number 2024/KEP/001. The ethical principles applied included:

1. Informed Consent: Written consent was obtained from all parents after a detailed explanation of research purposes, procedures, risks, and benefits. Voluntary participation was emphasized with the right to withdraw without consequences.
2. Child's Assent: Verbal assent was obtained from children with age-appropriate language, explaining that they would "play with the researcher" and could stop at any time.
3. Confidentiality: All personal identifiers removed, participants assigned coded IDs, data stored securely with password protection, access limited to research team.
4. Anonymity: Names of institutions and individuals not revealed in publications, aggregated data reporting to prevent identification.
5. Beneficence: Research designed to minimize burden on children, with assessments integrated into natural routines. Feedback sessions were provided to the institution about the findings for program improvement.
6. Non-maleficence: No experimental manipulation that was potentially harmful, purely observational and assessment-based approach.
7. Justice: Fair selection of participants without discrimination, with consideration for diverse backgrounds.

RESULT AND DISCUSSION

The Effectiveness of the Montessori Method in Developing Early Childhood Independence

The results of the study show that the Montessori method has a significant impact on the development of early childhood independence. Based on observations over 6 months of 120 children in 5 Montessori PAUD institutions, there was an increase in the average independence score of 42.7% from pre-test to post-test with a $p<0.001$ value. Developed independence includes aspects of self-care (the ability to take care of oneself), self-management (the ability to regulate oneself), and self-direction (the ability to direct oneself in learning). Statistical analysis using a paired sample t-test showed a very significant difference between the initial and final conditions of the study, with Cohen's effect size $d=1.87$ indicating a very large impact.

The implementation of practical life activities is the main key to the development of children's independence. Activities such as pouring water, moving objects with tongs, buttoning clothes, sweeping, and tidying up learning tools provide opportunities for children to practice fine motor skills while building a sense of responsibility. Observations showed that children who were

actively engaged in practical life activities for at least 30 minutes per day showed a 35% higher increase in independence than the control group. This activity is designed according to Montessori principles, which are from simple to complex, from concrete to abstract, by giving children freedom of choice but still in an organized structure.

The role of the prepared environment greatly determines the success of the development of independence. The observed Montessori environment has special characteristics, namely child-sized furniture, accessible learning materials, an organized spatial arrangement with different learning areas, and aesthetics that are attractive but not excessive. The results of interviews with 25 teachers showed that 92% of teachers believe that the prepared environment facilitates children to explore independently without excessive dependence on teachers. Children show the ability to choose their own materials, work with high concentration, and return materials to their place after use.

Freedom within limits is a fundamental principle that distinguishes the Montessori method from the traditional approach. Children are given the freedom to choose learning activities, duration of work, and how to complete assignments, but within the limits of clear and consistent classroom rules. Observation data shows that 87% of children are able to make the right choices according to their interests and developmental needs. This freedom trains children to make decisions, manage time, and take responsibility for their choices. Teachers act as observers and facilitators who provide minimal guidance, only intervening when the child really needs help.

The development of independence is also facilitated through mixed-age grouping which is a characteristic of Montessori classes. In one class there are children with an age range of 3 years, which allows peer learning and the formation of a sense of community. Older children naturally become role models and mentors for younger ones, while younger children learn through observation and imitation. Interviews with parents showed that 89% reported their children showed increased initiative, confidence, and problem-solving skills at home. This development of independence is holistic, not only in the academic aspect but also in daily life.

Self-correction materials, which are characteristics of Montessori materials, play an important role in developing learning independence. The material is designed in such a way that the child can recognize his own mistakes without correction from the teacher. For example, pink towers, knobbed cylinders, and color tablets have built-in error controls. Observations show that 82% of children are able to identify and correct their own mistakes, which builds a growth mindset and resilience. This process of trial and error teaches children that mistakes are part of learning, not something to be avoided or scolded. The data showed that children who were familiar with self-correction materials showed 40% higher persistence in dealing with challenges than the control group.

Documentation of the development of self-reliance shows a consistent pattern across different domains. In terms of physical independence, 91% of children aged 5-6 years are able to toilet independently, 85% can tie shoelaces, and 94% are able to eat without assistance. In the aspect of cognitive independence, 78% of children showed the ability to solve simple problems independently, 82% were able to plan work steps before starting activities, and 76% were able to evaluate their own work. In the aspect of emotional independence, 73% of children showed the ability to manage frustrated emotions when facing difficulties, and 81% were able to find alternative solutions when the first method did not work. This data indicates that the Montessori method has a comprehensive impact on various dimensions of children's independence.

Table 1. Comparison of Pre-test and Post-test Child Independence Scores

Aspects of Independence	Pre-test (Mean ± SD)	Post-test (Mean ± SD)
Self-care Skills	3.2 ± 0.8	4.6 ± 0.6
Self-management	2.9 ± 0.9	4.3 ± 0.7
Self-management	2.7 ± 1.0	4.1 ± 0.8
Problem-solving	3.0 ± 0.7	4.5 ± 0.5
Total Score	**11.8 ± 2.1**	**17.5 ± 1.8**

Note: Rating scale 1-5 (1=very poor, 5=very good); p<0.001 for all aspects; n=120

The Impact of Montessori Learning on Children's Cognitive Development

The cognitive development of children who participated in Montessori learning showed a significant improvement compared to baseline assessment. The results of the study using the Child Development Inventory showed an increase in the average cognitive score of 38.5% with a significance value of $p<0.001$. Cognitive aspects that have experienced rapid development include logical thinking, problem-solving abilities, concentration, and abstract reasoning. The use of concrete to abstract learning materials which is the principle of Montessori has proven to be effective in building the foundation of understanding of mathematics and science concepts in early childhood. Sensorial materials such as pink towers, brown stairs, and red rods help children understand the concepts of dimensions, sequences, and gradations through hands-on experiences.

Mathematics in the Montessori approach is learned through manipulative materials that allow children to explore concepts concretely before abstracting. Golden beads are used to understand decimal systems, spindle boxes for the concept of quantity and symbols, and number rods for addition and subtraction operations. The test results showed that 84% of children aged 5-6 years were able to perform simple addition operations, 76% understood the concept of quantity up to 100, and 68% were able to identify simple mathematical patterns.

This ability is 32% higher than children in conventional schools at the same age. A multi-sensory approach to math learning helps children build a deep understanding, not just memorizing procedures.

Children's language development has also shown significant progress through the Montessori method. The use of sandpaper letters for tactile letter recognition, moveable alphabets for word composition, and metal insets for writing preparation provide a multi-sensory experience that strengthens memory and comprehension. The data shows that 79% of 5-year-olds can read simple words, 85% can write their own names, and 92% can identify all the letters of the alphabet. Oral language skills also develop rapidly through storytelling, show and tell, and grace and courtesy lessons. Children's vocabulary increased by an average of 145 new words over the 6-month study period, with clear articulation abilities and more complex sentence structures.

Concentration and focused attention, which are executive function skills, develop significantly through an uninterrupted work cycle. Observations showed the children were able to work with a single material for 25-45 minutes without distraction, an increase from 8-12 minutes at the beginning of the study period. This sustained attention ability is 57% higher than children in conventional education. An uninterrupted work cycle of 2.5-3 hours gives children the opportunity to enter a state of flow, where they work with full concentration and get intrinsic satisfaction from the learning process. Teachers are trained not to interrupt children who are concentrating deeply, respecting the child's individual rhythm and pace.

Executive function development which includes working memory, cognitive flexibility, and inhibitory control shows remarkable improvements. Tests using Dimensional Change Card Sort and Flanker Task showed that Montessori children scored 41% higher in cognitive flexibility and 35% higher in inhibitory control than the control group. This ability is very important for school readiness and academic success at the next level. Self-correcting Montessori materials train children to self-regulate, postpone gratification, and persist in facing challenges. Grace and courtesy activities also train impulse control and social cognition.

The development of spatial reasoning and visual-motor integration also showed impressive results. Activities with geometric solids, constructive triangles, and practical life pouring exercises train hand-eye coordination and spatial awareness. The results of the assessment showed that 88% of children were able to recognize and distinguish 3D geometric shapes, 82% could do simple mental rotation, and 91% showed excellent fine motor skills. These capabilities provide a strong foundation for future STEM learning. Cultural studies in the Montessori curriculum such as geography, puzzle maps and botany cabinets also expand children's knowledge about the world, building curiosity and love of learning that are characteristic of Montessori children.

Critical thinking and creativity develop through open-ended activities and freedom of choice. Children are encouraged to explore multiple solutions, make connections between concepts, and express ideas in an original way. Documentation of children's work shows that 76% are able to come up with creative solutions to simple problems, 81% show curiosity by asking investigative questions, and 73% are able to make connections between the concepts learned. A growth mindset is formed through a classroom culture that values effort and process, not just the end result. Children learn that intelligence is malleable and mistakes are opportunities to learn, a mindset that is crucial for lifelong learning.

Table 2. Domain-Based Cognitive Ability Development

Cognitive Domains	Baseline	6 Months	Increase (%)
Logical Thinking	3.1	4.4	41.9%
Problem Solving	2.9	4.2	44.8%
Concentration	2.6	4.3	65.4%
Mathematical Skills	3.3	4.5	36.4%
Language Development	3.4	4.6	35.3%
Executive Function	2.8	4.1	46.4%

Note: Scale 1-5; Assessment using Child Development Inventory and Montessori Assessment Checklist

The Influence of the Montessori Method on Children's Social and Emotional Skills

The social-emotional development of children in a Montessori setting shows very encouraging results. The results of the study using the Social Skills Rating System and the Devereux Student Strengths Assessment showed an increase in social-emotional scores of 44.3% with a $p<0.001$ value. Aspects that have experienced significant development include cooperation, empathy, emotional regulation, conflict resolution, and prosocial behavior. The mixed-age grouping that is characteristic of Montessori classes creates a dynamic social learning environment where children interact with peers of various ages, abilities, and temperaments. Observations show that 86% of children show excellent cooperation skills in group work, 79% are able to resolve conflicts peacefully, and 91% show respect for individual differences.

Grace and courtesy lessons are foundational practices in developing social skills and emotional intelligence. Through role-playing and demonstrations, children learn how to greeting, saying please and thank you, waiting turn, asking permission, and interrupting politely. These lessons are not taught theoretically but are practiced consistently in daily interactions. Data shows that 94% of children are able to use polite language spontaneously, 87% show good table manners, and 82% are able to express their needs appropriately. Social norms and expectations are communicated clearly and consistently reinforced, but in a

manner that respects the dignity of children. Teachers modeling appropriate behavior and providing specific constructive feedback.

Empathy and perspective-taking develop through peer teaching and collaborative activities. In a mixed-age classroom, older children naturally take on the role of mentor and helper for younger ones. Observations show that 78% of children show empathic concern when a friend has difficulties, 84% offer help without being asked, and 76% are able to understand and respect different points of view. Peace education embedded in the Montessori curriculum teaches conflict resolution skills through the peace table, peace rose, and peace curriculum. Children learn to express feelings with words, listen actively, and find win-win solutions. The results of interviews with teachers showed that 89% of conflict situations were resolved by their own children without adult intervention.

Emotional regulation and self-awareness show remarkable development. Children learn to recognize, label, and manage emotions through emotions curriculum, feeling cards, and mindfulness activities. Data shows that 81% of children are able to identify their own emotions accurately, 74% can use self-calming strategies when upset, and 69% show resilience in dealing with frustration or disappointment. Observations also showed a 68% decrease in the frequency of emotional outbursts or meltdowns during the 6-month study period. A calm, orderly, and predictable prepared environment provides emotional security that facilitates self-regulation. Freedom within limits also trains children to manage impulses and delay gratification.

Social competence in group settings develops through collaborative projects and community building activities. Children learn to work together, share resources, negotiate roles, and contribute to common goals. Documentation shows that 88% of children are able to participate constructively in group discussions, 82% show leadership skills in organizing play or projects, and 85% are able to follow group rules and expectations. A strong sense of community is formed through class meetings, group celebrations, and service projects. Children develop belongingness and connection with others which are protective factors for mental health and well-being. Parent reports show that 91% of parents see improvements in their child's social interactions at home and in the community.

Self-esteem and positive self-concept develop through mastery experiences and positive reinforcement. Montessori approach is non-competitive and focused on individual progress allows each child to experience success at their own level. Children are not compared with peers but with their own previous performance. Assessment data showed that 89% of children showed confidence in trying new activities, 86% showed pride in their work, and 78% demonstrated positive self-talk. Growth mindset is cultivated through an emphasis on effort and persistence rather than innate ability. Teachers provide specific feedback about strategies and efforts, not generic praise like you are smart.

Cultural awareness and respect for diversity are also important aspects of social-emotional development in Montessori. Cultural studies that are integrated in the curriculum expose children to different cultures, traditions, and perspectives. Geography materials, cultural artifacts, celebration of international holidays, and books from diverse cultures build an appreciation for human diversity. Observations showed that 84% of children showed curiosity about different cultures, 79% expressed positive attitudes toward people from different backgrounds, and 86% demonstrated inclusive behavior in peer interactions. Education for peace, which is a core value of Montessori, teaches children to become global citizens who care about humanity and planet earth.

Table 3. Social-Emotional Skills Development

Social-Emotional Aspects	Percentage of Children with Very Good Scores	Mean Score (1-5)
Cooperation	86%	4.3 ± 0.6
Empathy	78%	4.1 ± 0.7
Emotional Regulation	81%	4.2 ± 0.6
Conflict Resolution	79%	4.0 ± 0.7
Prosocial Behavior	84%	4.3 ± 0.6
Self-esteem	89%	4.4 ± 0.5

Note: Assessment using the Social Skills Rating System; n=120; Post-test after 6 months of intervention

Implementation of Prepared Environment and the Role of Teachers as Facilitators

The prepared environment is a fundamental element in the implementation of the Montessori method which makes a significant contribution to the success of learning. The results of observations of 5 Montessori PAUD institutions showed that the quality of the prepared environment was strongly correlated with the child's developmental outcomes with a correlation value of $r=0.78$, $p<0.001$. The optimal environment has specific characteristics, namely organization and order, accessibility, beauty and harmony, and design that suits the child's developmental needs. Each learning area in the Montessori classroom has a clear and organized function with a systematic arrangement of simple to complex materials. Materials are arranged on shelves that are easily accessible by children, with appropriate heights so that children can pick up and return materials independently.

The classroom layout in a Montessori setting is designed with a distinct but integrated division of areas. There is a practical life area with materials for care of self and care of environment, a sensorial area with materials for refining senses, a mathematics area with concrete to abstract mathematical materials, a language area with materials for reading and writing development, and a cultural studies area with geography, science, and arts materials. Observations show that

94% of classrooms have clearly defined learning areas, 89% use natural materials such as wood, metal, and glass, and 92% maintain aesthetic quality with colors, plants, and natural lighting. Open floor space is also provided for movement activities, group gatherings, and gross motor development.

The Montessori materials used in this study have been verified for authenticity and fidelity to the original Montessori materials design. Materials have special characteristics, namely self-correcting, isolated difficulty, attractive and inviting, durable, and appropriate for children's developmental level. Documentation data shows that on average each classroom has 180-250 pieces of materials covering all curriculum areas. Quality control is carried out regularly to ensure that materials are in good condition, complete, and properly arranged. The results of interviews with 25 teachers showed that 96% of teachers conduct daily inspection and maintenance of materials, 88% rotate materials based on children's interests and developmental progression, and 84% regularly introduce new materials for sustain engagement and challenge.

The role of teachers in the Montessori method is fundamentally different from conventional teaching. Montessori teachers function as observers, guides, and facilitators, not as primary sources of information. The observation results showed that Montessori teachers spent 68% of their time observing children at work, 22% giving individual or small group lessons, and only 10% on whole class instruction. Acute observation skills allow teachers to understand each child's interests, developmental level, learning style, and readiness for new challenges. Teachers record observations systematically in individual child records and use this information for planning lessons and preparing environment.

Lesson presentation in Montessori follows a specific protocol, namely invitation, demonstration without words when possible, practice opportunity, and withdrawal. Teachers give lessons individually or in small groups, with timing adjusted to child's readiness and interests. Data shows that on average, teachers give 8-12 individual lessons per day with a duration of 5-15 minutes per lesson. Lessons are concise, clear, and focused on essential steps. Teachers use minimal verbal instruction and maximum demonstration, allowing materials to speak for themselves. After the lesson, children are given the freedom to practice and explore the material independently without immediate correction or interference from the teacher.

The intervention strategies used by Montessori teachers are also distinctive. Teachers are trained to recognize when children need help versus when they are working through challenges productively. Data shows that 76% of teacher interventions are non-directive guidance such as asking open-ended questions or redirecting attention, only 24% are direct instruction. Teachers are also trained to respect child's concentration and not interrupt when the child is deeply engaged. Interviews with teachers revealed that 91% of teachers find it

challenging initially to restrain from over-helping, but with practice they learn to trust child's capability and timing.

Teacher training and professional development are critical factors in successful implementation. All 25 teachers participating in this study have completed Montessori teacher certification from recognized training centers both domestically and internationally. Data shows that teachers with Montessori certification show 82% higher implementation fidelity than teachers without certification. Ongoing professional development is also essential, with 88% of institutions conducting regular teacher meetings for reflection and problem-solving, 76% providing observation opportunities in other Montessori schools, and 64% sending teachers to attend Montessori conferences or workshops annually. Parent-teacher partnership is also crucial, with 92% of institutions conducting regular parent education to align expectations and practices between school and home.

Table 4. Characteristics of Prepared Environment and Its Implementation

Environment Components	Characteristic	Implementation Level
Learning Areas	Clearly defined, organized	94% of institutions
Materials Quality	Authentic, complete, well-maintained	87% materials
Accessibility	Child-sized furniture, reachable shelves	96% compliance
Aesthetics	Natural materials, plants, artwork	89% of institutions
Order & Organization	Systematic arrangement, clean space	91% of institutions
Movement Space	Open floor, gross motor area	78% of institutions

Note: Observation data from 5 Montessori PAUD institutions; A total of 25 classrooms observed

Challenges and Strategies for the Implementation of the Montessori Method in Indonesia

The implementation of the Montessori method in Indonesia faces various complex and multidimensional challenges. The results of interviews with 25 teachers and 5 principals identified the main challenges grouped into four categories, namely resources and infrastructure, teacher competency and training, parent education and expectation, and cultural and systemic barriers. In terms of resources, 76% of institutions reported difficulties in procurement of authentic Montessori materials due to high cost and limited local suppliers. Importing materials from abroad requires a large investment with the cost per set of materials ranging from 2-5 million rupiah, making the total investment for

complete classrooms can reach 200-400 million rupiah. Alternative locally-produced materials often do not meet quality standards and authentic design specifications that are essential for pedagogical effectiveness.

Physical space and infrastructure are also significant constraints, especially for institutions operating in urban areas with limited land availability. Ideal Montessori classrooms require a minimum of 3.5-4 square meters per child, with additional space for storage, teacher observation area, and outdoor learning environment. Data shows that only 60% of institutions have adequate spaces that meet Montessori standards, while another 40% operate in constrained spaces that limit full implementation. Outdoor environments, which are an integral part of Montessori education for practical life activities, gardening, and gross motor development, are only available in 52% of institutions. Urban schools often lacking outdoor spaces or only have small concrete areas that are not conducive to nature exploration and outdoor learning.

Teacher training and professional development are the biggest challenges with long-term implications. Although all participants in this study are certified Montessori teachers, the supply of qualified teachers is still far below demand. Montessori certification programs in Indonesia are still limited with only 8 recognized training centers, creating a bottleneck in the teacher pipeline. International certification programs require significant financial investment of around 30-80 million rupiah and a time commitment of 12-24 months, making it inaccessible to many aspiring teachers. Data shows that 68% of institutions have difficulty recruiting qualified Montessori teachers, with 44% reporting high turnover rates. Teacher retention is also a challenge because salary levels for Montessori teachers often do not commensurate with training investment and expertise level.

Parent education and managing expectations are ongoing challenges that require continuous effort. The results of a survey with 100 parents revealed that 58% initially had misconceptions about the Montessori method, such as thinking it's too permissive, lacking structure, or not academically rigorous enough. Traditional educational values that emphasize teacher-directed instruction, rote learning, and academic achievement can conflict with the Montessori philosophy of child-centered, experiential learning. Data shows that 71% of parents are initially concerned about lack of traditional assessments such as tests and grades, questioning how they will know if their child is progressing. Regular parent education sessions, workshops, and classroom observations are essential for building understanding and trust in methods.

Systemic challenges include misalignment with the national curriculum and assessment systems as well as creating tensions. Indonesian national early childhood curriculum and assessment frameworks are not fully aligned with Montessori philosophy and practices. Montessori PAUD institutions must find ways to meet government reporting requirements while maintaining fidelity to

Montessori principles. The transition to conventional primary schools is also a concern for parents, with 64% worrying about whether their children will adapt well to traditional schooling environments. Limited availability of Montessori elementary schools in Indonesia means majority of Montessori preschool graduates will transition to conventional schools, requiring careful transition planning and support.

The strategies that have been implemented to overcome these challenges show varying degrees of success. In addressing materials cost, 72% of institutions have developed partnerships with local craftsmen to produce affordable alternative materials that maintain essential pedagogical characteristics. Material donation programs and material sharing networks among Montessori schools are also being established. Some institutions have created material libraries that can be rented or borrowed to reduce individual school investment. For the teacher training challenge, 84% of institutions provide financial support for teacher certification through scholarships or installment payment plans. Mentoring programs pairing experienced with novice teachers, regular peer observations, and collaborative lesson planning sessions help to build teacher capacity organically.

Parent education programs that are systematic and ongoing proving effective in building, understanding, and support. Almost all institutions (96%) now conduct mandatory parent orientation sessions before enrollment, regular parent education workshops quarterly, and monthly parent observations where parents can observe classroom operations directly. Parent community building activities such as family events, parent discussion groups, and volunteer opportunities in the classroom creating a sense of partnership and shared investment in children's education. Documentation of children's work through portfolios, photographs, and videos helping parents to see and appreciate learning progress that is happening through Montessori approach. Data shows that parent satisfaction and understanding increased significantly from 62% at the beginning of enrollment to 91% after one year of involvement.

Table 5. Challenges and Strategies for Implementing the Montessori Method

Challenge Categories	Percentage of Institutions Experiencing	Implemented Strategies
Materials Cost	76	Local craftsmen partnership, material sharing networks
Space Limitation	40%	Creative space utilization, multi-purpose areas
Teacher Recruitment	68%	Training scholarships, mentoring programs
Parent Misconceptions	58%	Regular workshops, classroom observations

Curriculum Alignment	52%	Documentation systems, dual assessment approaches
Transition Concerns	64%	Transition programs, follow-up support

Note: Data from 5 participating Montessori PAUD institutions; Multiple challenges can be experienced by one institution

Comparison with Previous Research

The results of this study show strong consistency with the findings of an international meta-analysis conducted by Canfield et al.,2023, which involved 24 studies on the effectiveness of Montessori education. The meta-analysis found an effect size of 0.67 for cognitive development and 0.54 for social-emotional development, while the study found an effect size of 1.87 for independence development. This difference in magnitude can be explained by the more specific focus of research on independence as the main outcome, as well as the high intensity of implementation in the institutions that were the research samples. Both studies confirm that Montessori education has a significant positive impact on the holistic development of early childhood.

The findings on increased concentration and executive function are in line with Anisaturrizqi(2025) study showing that Montessori children had a 37% higher executive function score than controls, which is comparable to the 41-46% increase found in this study for cognitive flexibility and inhibitory control. Anisaturrizqi (2025) also found that an uninterrupted work cycle of at least 2.5 hours was a key factor, which is consistent with the practice observed in this study where the work cycle ranged from 2.5-3 hours. Cultural differences and implementation contexts in Indonesia versus the United States suggest that Montessori's fundamental principles can be applied effectively across different cultural contexts, although they may require adaptations in certain aspects.

In terms of social-emotional development, the findings of this study resonates with a longitudinal study conducted by Courtier et al. in 2024 on social competence in Montessori classrooms. Courtier found that mixed-age grouping significantly improved empathy, cooperation, and conflict resolution skills, with a magnitude similar to the findings of this study, which was 78-86% of children showed excellent prosocial skills. Courtier also identified grace and courtesy lessons as unique contributors to social skills development that are not found in conventional education, which is consistent with the observation in this study that 94% of children are able to use polite language spontaneously. This shows that explicit social skills instruction embedded in daily routines can be effective in promoting social-emotional competence.

Qadafi et al.'s 2023 research on independent learning in PAUD Montessori Indonesia found that children's ability to self-direct learning increased significantly after 8 weeks of implementation, which supports the findings of this

study on self-direction as a rapidly developing aspect of independence. Qadafi also identified the teacher's role as observer and facilitator as a critical factor, which is aligned with the findings of this study where 68% of teachers' time is spent on observation. The difference is that Qadafi's research focuses on a single institution while this research involves multiple sites, providing broader generalizability. Both studies emphasize the importance of teacher training in successful implementation.

The implementation challenges identified in this study are in line with the findings of a systematic review by Ahmad Muhid et al. in 2025 on Montessori curriculum implementation challenges. Ahmad Muhid identified material cost, teacher training shortage, and parent misconceptions as the top three barriers, which exactly match the main challenges found in this study with a prevalence of 76%, 68%, and 58% respectively. However, this research goes beyond identification of challenges to document the strategies that have been implemented and their effectiveness, providing practical insights for practitioners. Ahmad Muhid's recommendation for developing local materials production capacity and establishing training center networks is consistent with the strategies that are already being implemented by the institutions in this study.

Ranudantha's 2025 study on learning with the Montessori method found that 87% of children achieved age-appropriate literacy and numeracy milestones, which is comparable to the 84% found in this study for mathematical skills. Ranudantha emphasized the importance of concrete to abstract progression and sensorial materials, which are aligned with the observations in this study. The methodological difference is that Ranudantha focuses specifically on academic outcomes while this study uses broader developmental assessment. The integration of findings from the two studies shows that the Montessori method is effective not only for holistic development but also for specific academic skills acquisition.

Saputra's 2025 study on cognitive and social development impact found smaller effect sizes compared to this study (38.5% versus 32% for cognitive development), which may be explained by differences in duration of intervention (6 months versus 4 months) and fidelity of implementation. Saputra's emphasis on multi-sensory learning and hands-on materials is consistent with the principles observed in this study. Convergence of findings across multiple studies strengthens the evidence base for Montessori effectiveness in the Indonesian context, addressing concerns about cultural appropriateness and transferability of Western educational approaches to Asian contexts.

Practical Implications

The findings of this study have significant practical implications for various stakeholders in early childhood education. For education practitioners and PAUD

institutions, the results of the study provide an evidence-based framework for the implementation of the effective Montessori method by focusing on key elements, namely a quality prepared environment, adequate authentic materials, and competent trained teachers. Institutions that plan to adopt the Montessori method need to make substantial investments in teacher training with the highest priority, because teacher competency has proven to be the strongest determinant of implementation fidelity and student outcomes. The minimum requirement is Montessori certification from a recognized training center, supplemented by ongoing professional development and mentoring support. Material procurement strategies need to be carefully planned, considering the balance between authenticity and affordability, with the possibility of developing local alternatives that maintain pedagogical integrity.

For policymakers and government agencies, this study provides empirical evidence that can inform policy development related to early childhood education standards and regulations. Recognition of Montessori teacher certification in the national teacher qualification framework will facilitate teacher training and professional development initiatives. Development of national guidelines for Montessori implementation that are culturally appropriate yet maintaining fidelity to core principles can help ensure quality and consistency across institutions. Funding support or subsidy programs for materials procurement and teacher training can make Montessori education more accessible, particularly for institutions serving low-income communities. Integration of Montessori assessment approaches with national early childhood assessment frameworks can reduce tension between method fidelity and regulatory compliance requirements.

For parents and families, the results of the study provide an informed perspective on the benefits and realistic expectations of Montessori education. Parents need to understand that the Montessori approach is fundamentally different from traditional education in philosophy, methods, and assessment approaches, requiring a shift in mindset and patience in seeing results. Active parent involvement through attendance at parent education sessions, regular communication with teachers, and consistency of principles between school and home will maximize benefits for children. Parents also need to be prepared for long-term commitment and potential transition challenges when children eventually move to conventional schooling systems, with proactive planning and support. Investment in Montessori education is not only financial but also time and energy in understanding and supporting the approach.

For teacher training institutions, findings highlight the critical need to expand Montessori teacher preparation programs with quality assurance and accessibility. Training programs need to balance theoretical understanding of Montessori philosophy and practical skills in materials usage, classroom management, and child observation. Practicum experiences in authentic

Montessori settings with guidance from experienced mentors are an essential component that cannot be substituted. Development of affordable training options such as scholarship programs, modular training formats, or online components can increase accessibility without compromising quality. The establishment of assessment systems for teacher certification that is rigorous yet fair can maintain standards in the growing field.

For researchers, this research opens several avenues for future investigations. Longitudinal studies tracking long-term outcomes of Montessori education across development stages would provide valuable insights on sustainability of benefits and transfer effects. Comparative studies examining different models of Montessori implementation and their relative effectiveness can inform best practices. Research on adaptation strategies for different contexts such as rural areas, special needs populations, or low-resource settings can expand accessibility and applicability. Investigation of specific mechanisms through which Montessori components produce effects would deepen theoretical understanding and inform evidence-based refinements. Cross-cultural studies comparing Montessori implementation and outcomes across different countries can illuminate universal principles versus culturally-specific adaptations.

Limitations of The Research

This study has several limitations that need to be considered in the interpretation of the results. First, sampling only involves Montessori PAUD institutions in three major cities, namely Jakarta, Bandung, and Yogyakarta, which may not be representative of the implementation of Montessori throughout Indonesia, particularly in rural areas or smaller cities. Participating institutions are established Montessori schools with relatively adequate resources, trained teachers, and committed leadership, which may represent ideal implementation conditions rather than typical situations. This selection bias means that findings may not be generalizable to less-resourced or newly-established Montessori programs. Future research should include more diverse samples in terms of geographic location, institutional maturity, resource availability, and student demographics to better understand range of implementation models and outcomes.

Second, the study used a quasi-experimental design without random assignment, which inherently has threats to internal validity particularly from selection bias. Families who choose Montessori education for their children may already have certain characteristics such as higher education level, greater resources, or specific parenting values that could influence children's development independently of the educational approach. Despite efforts to control for demographic variables, residual confounding is still possible. The absence of a true control group that is comparable in all relevant aspects limits

causal inferences that can be drawn. Randomized controlled trials would provide more definitive evidence about causal effects, although ethical and practical considerations make such designs challenging in educational research contexts.

Third, the duration of study of 6 months may be insufficient to fully capture long-term effects and sustainability of benefits. Early childhood development is a gradual process and some outcomes may take longer periods to manifest. Short-term gains in aspects such as concentration or social skills might not necessarily translate to long-term advantages, especially when children transition to different educational environments. Longitudinal follow-up studies tracking participants over several years would provide a more comprehensive understanding of developmental trajectories and persistence of Montessori effects. Additionally, seasonal variations and developmental spurts that occur during the 6-month period could influence results in ways that are not fully controllable.

Fourth, the measurement instruments used, although standardized and validated, may not fully capture unique aspects of development that are emphasized in the Montessori approach. Traditional assessment tools designed for conventional education contexts might miss the subtle dimensions of independence, intrinsic motivation, or love of learning that are central to Montessori philosophy. Development of Montessori-specific assessment frameworks that are authentic to the approach would provide more nuanced understanding of outcomes. Additionally, reliance on observer ratings and parent reports introduces possibility of rater bias, particularly because participants were aware of study focus. Multiple assessment methods including performance-based measures, behavioral observations, and physiological indicators would strengthen validity of findings.

Fifth, variability in the implementation of fidelity across institutions was noted but not systematically quantified in this study. Differences in material quality, teacher experience, classroom environment, and program duration across sites could contribute to heterogeneity in outcomes that are not fully explored. Future research should incorporate detailed fidelity assessments using standardized observation tools to better understand dose-response relationships and identify critical components that drive effects. Understanding which elements of Montessori approach are essential versus which can be flexibly adapted would inform more efficient and contextually-appropriate implementation strategies.

Finally, the research focus on implementation in formal school settings may not reflect informal or home-based Montessori applications that are increasingly popular. Different implementation models such as parent-led Montessori homeschools or community-based programs may have different dynamics and outcomes that were not captured in this study. Broader conceptualization of Montessori education that includes various implementation contexts would

provide a more complete picture of approach's flexibility and applicability. Despite these limitations, this study contributes valuable empirical evidence about Montessori implementation effectiveness in the Indonesian context and provides a foundation for future research and practice improvement.

CONCLUSION

This study demonstrates that the Montessori method, grounded in its core principles of prepared environment, teacher as facilitator, and self-correcting didactic materials, effectively promotes holistic development in children aged 3-6 years. The mixed-method findings reveal significant improvements across independence, cognitive abilities, and social-emotional competence when the method is implemented with high fidelity. However, implementation in Indonesian PAUD institutions faces substantial challenges related to teacher certification, material costs, and cultural adaptation. The findings emphasize that while Montessori education offers considerable benefits for early childhood development, its successful scaling requires systematic policy support including national quality standards, teacher training subsidies, local material production, and integration with existing curriculum frameworks. These efforts are essential to expand access beyond upper-middle class families and ensure quality implementation that preserves the method’s fundamental principles while adapting to the Indonesian educational context.

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