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THE IMPACT OF THE MONTESSORI METHOD ON EARLY CHILDHOOD COUNTING SKILLS

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Abstract

This study examines the impact of the Montessori method on early childhood numeracy skills, specifically focusing on counting, number comprehension, and classification. A quasi-experimental design was over a 2-week period, the children participated in three sessions per week. Data were collected using pretest and posttest measurements, and statistical analyses, including t-tests and effect size calculations, were performed to evaluate the results. The findings reveal a significant improvement in the counting skills of children in the Montessori group compared to the control group, with a very large effect size (Cohen's d = 3.050). The Montessori method not only enhanced children's mathematical abilities but also contributed positively to their psychological development, reducing anxiety and increasing self-confidence. This study underscores the effectiveness of hands-on, experiential learning environments in supporting both cognitive and emotional growth in young children.

Keywords: Montessori method: early childhood education: counting skills.

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Introduction

Learning math in early childhood is one of the main foundations in their cognitive development, which has a broad impact on their abilities in various aspects of life. From an early age, the introduction of basic math concepts, such as numbers, shapes and patterns, can have a significant impact on a child's overall cognitive development. Sinthia (2024) asserts that understanding these basic concepts greatly influences children's future intellectual abilities. Berk (2013) also states that the right approach to learning math at an early age not only helps children understand more complex concepts, but also contributes to their emotional development. The selection of effective learning methods also plays an important role in the development of children's numeracy skills. Interactive and experiential learning can stimulate children's interest in math, as well as support their psychological development. Nurhayati (2022) mentioned that the Montessori approach, which prioritizes direct experience, is able to strengthen children's counting skills by utilizing props that stimulate their senses. Children who learned math with the Montessori method showed better and faster understanding compared to traditional methods (Lillard et al., 2017). Learning math at an early age is crucial for children's cognitive and emotional development. The introduction of basic math concepts significantly impacts their intellectual growth. The Montessori approach, which emphasizes hands-on, experiential learning, proves to be an effective method in enhancing children's numeracy skills, as it stimulates their senses and engages them more (Nur Afifah, 2020).

The Montessori method itself emphasizes children's freedom to learn through direct experience with materials designed to stimulate their senses. The basic principles of Montessori demand an environment that is appropriate to the child's stage of development. Milinković & Bogavac (2011) revealed that an approach tailored to children's individual needs, as applied in the Montessori method, has a positive impact on the development of their cognitive abilities, including in mathematics. Lillard (2021) also adds that the use of Montessori materials, such as Golden Beads and Spindle Boxes, can clarify number concepts and basic operations in a fun and concrete way. In addition, learning math at an early age plays an important role in the psychological aspects of children. Children who learn math in a fun and developmentally appropriate way tend to have higher self-confidence. Children who followed Montessori-based learning not only showed improved math ability, but also had lower anxiety levels and better social skills compared to children who did not follow the approach (Gentaz & Richard, 2022). Therefore, the Montessori method not only supports cognitive development, but also helps in the formation of children's social and emotional aspects. Through a new approach in early

childhood mathematics learning by combining cognitive and psychological aspects, specifically through the Montessori method, it emphasizes how Montessori not only improves children's mathematical abilities, but also reduces anxiety and improves their social skills. In addition, this article also highlights the importance of experiential learning that has a positive impact on children's psychological development, making it more relevant in today's educational context.

Methods

This study used a quasi-experimental experimental design to examine the effect of the Montessori method in learning mathematics on early childhood counting skills at RA Al-Hakim Al-Hurriyah Rondaman Dolok. The sample consisted of 27 children, with 13 children in the control class and 14 children in the experimental class. Learning was conducted for 2 weeks, with 3 meetings each week. The experimental group used the Montessori method, while the control group used the traditional method. Numeracy skills were measured through math tests covering numbers, addition, and patterns. The instruments used in this study have undergone a validation process involving subject matter experts and methodology experts to ensure their appropriateness and reliability in measuring early childhood numeracy skills.

Data were analyzed using t-test to measure the difference in counting ability between groups and calculating the effect size with Cohen's d to determine the calculate the influence of the Montessori method (Arikunto, 2019; Sugiyono, 2020). Research ethics were maintained by obtaining parental consent and maintaining confidentiality of participant data. This study aims to identify the significant effect of the Montessori method on early childhood numeracy skills. The relatively small sample size and short duration limit the ability to generalize findings broadly. Future studies with larger samples and longer interventions are recommended.

Results

In this section, the results of the analysis conducted to measure the effect of using the Montessori method in learning mathematics on early childhood counting skills at RA Al-Hakim Al-Hurriyah Rondaman Dolok are presented. This study involved two groups, namely the experimental group that followed learning with the Montessori method and the control group that used traditional methods. The findings of this study are:

Table 1. Pretest Homogeneity Test Results.

		Levene's Test for Equality of Variances	
		F	**Sig.**
Nilai_Pretes	Equal variances assumed	.005	.942

F value = 0.005 and Sig. = 0.942, it can be concluded that the p-value is greater than 0.05 (0.942 > 0.05). This indicates that the variance between the pretest groups is homogeneous (equal), which means there is no significant difference in initial ability between the experimental and control groups. Therefore, it can be concluded that the initial ability (pretest) of both groups is the same, and the experiment can proceed without any bias caused by the difference in variance on the pretest.

After the experiment was implemented, the next step was to conduct a classical assumption test to ensure that the data qualified for further statistical analysis. This classical assumption test includes a normality test to check whether the data follows a normal distribution and a variance homogeneity test to ensure that the variance between groups is homogeneous.

Table 2. Posttest Normality and Homogeneity Test Result.

	Kolmogorov-Smirnov[a]			**Shapiro-Wilk**			**Levene's Test for Equality of Variances**	
	Statistic	df	Sig.	Statistic	df	Sig.	F	Sig.
Nilai_Posttes	.151	27	.114	.953	27	.259	.095	.761

Based on the results of Levene's Test for Equality of Variances, with F = 0.095 and Sig. = 0.761, it can be concluded that the variance between groups is homogeneous, which allows the experiment to be conducted without bias. The normality test results showed that the data were normally distributed, both according to Kolmogorov-Smirnov (Sig. = 0.114) and Shapiro-Wilk (Sig. = 0.259), as both p-values were greater than 0.05. After the classical assumption test was conducted, the next step was statistical analysis to evaluate the experimental results. The t-test and effect size were used to analyze the difference in counting ability between the

experimental group using the Montessori method and the control group using the traditional method. By conducting this analysis, it is expected to know the effect of using the Montessori method on improving early childhood counting skills.

Table 3. t-test Posttes Result

		t-test for Equality of Means		
		t	df	Sig. (2-tailed)
Nilai_Posttes	Equal variances assumed	7.918	25	.000
	Equal variances not assumed	7.866	23.583	.000

The Independent Samples t-Test results for Posttest Values show a significant difference between the experimental group and the control group. In Equal variances assumed, the t value = 7.918 with df = 25 and Sig. (2-tailed) = 0.000. Similarly, in Equal variances not assumed, the value of t = 7.866 with df = 23,583 and Sig. (2-tailed) = 0.000. Since the p-value is smaller than 0.05, it can be concluded that there is a significant difference in counting ability between the two groups after treatment. Therefore, the use of the Montessori method in math learning has a positive effect on improving early childhood counting skills.

Table 4. Effect Size Test Results

Independent Samples Effect Sizes

				95% Confidence Interval	
		Standardizer[a]	Point Estimate	Lower	Upper
Nilai_Posttes	Cohen's d	5.329	3.050	1.906	4.165
	Hedges' correction	5.496	2.957	1.848	4.039
	Glass's delta	5.782	2.811	1.450	4.135

a. The denominator used in estimating the effect sizes.

Cohen's d uses the pooled standard deviation.

Hedges' correction uses the pooled standard deviation, plus a correction factor.

Glass's delta uses the sample standard deviation of the control group.

The effect size results for the Posttest scores showed a highly significant effect between the experimental and control groups. Based on Cohen's d, a value of 3.050 was obtained, with

a 95% confidence interval between 1.906 and 4.165, which indicates a very large effect size. The effect of using the Montessori method on children's numeracy skills is very large, with an effect size value that shows a significant impact. Based on Cohen's d, Hedges' correction, and Glass's delta, the values obtained range from 2.81 to 3.05, which fall into the large effect category. This means that the Montessori method has a very strong effect on improving early childhood numeracy skills compared to traditional learning methods. To convert the effect size into percentage improvement, we can use the formula r^2 (coefficient of determination) obtained from Cohen's d. It was found that $r^2 \approx 0.699$, which means that the effect of the Montessori method on children's numeracy skills can be explained about 69.9% by the difference between the two groups. Thus, about 70% of the variation in counting ability can be explained by the use of the Montessori method.

Based on the results of the significant effect and also the effect size analysis for Posttest scores, a highly significant effect was found between the experimental group using the Montessori method and the control group, indicating a very large effect size, which indicates that the Montessori method has a very strong impact on improving early childhood numeracy skills. Previous research supports these findings, Berk (2013) states that a hands-on experience-based approach, as implemented in the Montessori method, can improve children's critical thinking and problem-solving skills. (Meylani, 2024; Nurhayati, 2022) also confirmed that math learning that involves concrete and interactive activities contributes greatly to children's cognitive development, including numeracy skills. The Montessori method also shows that this approach can optimize children's cognitive development, especially in aspects of mathematics and logical ability. (Rathunde, 2014). The application of the Montessori approach in early childhood education can increase engagement and academic achievement, including in math. Montessori has been shown to have a significant impact on improving children's numerical abilities and problem-solving skills. (Evans & Saracho, 2021; Robinson & Osana, 2019)

The effect size in the very good range also emphasizes that Montessori-based education has a positive effect on children's cognitive development, especially in learning mathematics. The math competence of 4-7 year old children who attended Montessori education with those who followed traditional methods in Greece. The results showed that Montessori children had higher scores in various aspects of math competence, such as sorting, classification, and number comprehension, compared to the control group (Gerker, 2024; Siaviki et al., 2025). The results of this study show that the use of the Montessori method in learning mathematics has a significant effect on early childhood numeracy skills. This method is proven to have a

great impact in improving children's math skills. Thus, the Montessori method can be considered as an effective alternative for improving counting skills in early childhood, as well as making an important contribution to the development of learning methods in early childhood education.

Discussion

The findings of this study found that the Montessori method has a significant effect in improving early childhood math and numeracy skills, and can support their psychological development. The application of the Montessori approach based on direct experience and learning through concrete props has proven effective in improving children's understanding of basic math concepts. This is because the application of the Montessori approach based on direct experience and learning through concrete props has been proven effective in improving children's understanding of basic mathematical concepts. Improved numeracy and psychological development of young children who attended Montessori education have better skills in understanding basic math concepts such as sequencing, classification, and number comprehension, compared to the control group using the traditional approach.

The Montessori method emphasizes hands-on experiential learning with concrete materials, which allows children to understand mathematical concepts more deeply and practically. Children are given the freedom to choose activities that interest them, which motivates them to learn actively. Hands-on experience with props that can be touched and moved helps children visualize and experience abstract concepts, such as numbers and mathematical operations, in a more intuitive way (Kamil & Asriyani, 2023; Laski et al., 2015; Nisa et al., 2019; Ongoren & Yazlik, 2019; Randolph et al., 2023). In addition, Montessori also emphasizes independent learning, which allows children to explore and choose activities that interest them, thus increasing intrinsic motivation for learning (Basargekar & Lillard, 2021). This suggests that this approach allows children to develop problem-solving skills and other cognitive skills, which are directly related to their ability in numeracy.

In addition to improving mathematical ability, Montessori also has a very good influence on children's psychological development. According to research by Rathunde (2001) and Siaviki et al., (2025), children who attended Montessori education showed lower anxiety levels and higher self-confidence compared to those who were taught with traditional methods. This may be due to the freedom given by Montessori to choose their own learning activities,

which leads to increased independence and development of self-control. This means that the application of the Montessori method can increase children's independence through activities that allow children to explore the surrounding environment actively and independently. This is similar to what was conveyed by Aisya et al., (2022 dan Damayanti (2019) where Montessori Learning in Forming Independent, Creative and Disciplined Characters in Early Childhood. In line with Vygotsky's social-cognitive theory, which emphasizes the importance of social interaction in learning, Montessori also supports children's psychological development through interaction with peers and teachers. Activities in age-diverse groups help children learn to collaborate, share and respect others' views, which enriches their social and emotional skills. Children in a Montessori environment tend to be more emotionally engaged in their learning, which contributes to better cognitive development (Kamii & DeVries, 1993).

The use of Montessori props not only improves children's mathematical skills but also reduces their academic stress. This suggests that experiential learning with concrete tools can create a more enjoyable and less intimidating learning environment for children, which in turn strengthens their psychological well-being. The Montessori method as a whole supports early childhood cognitive, emotional and social development. Through hands-on experiences, children not only hone their numerical and counting abilities but also develop important skills in problem-solving, critical thinking, and the ability to work independently and in groups. In addition, because Montessori pays attention to the balance between cognitive and emotional development, children who follow this method tend to have better psychological health, such as high self-confidence and strong emotional resilience. This method facilitates a more holistic and holistic learning process, which not only improves mathematical skills but also supports children's mental and emotional health.

In this discussion, the novelty of the research results is clearly evident when comparing them to prior studies in the field of early childhood mathematics education, particularly in the context of the Montessori method. The main objective of this study was to assess the impact of the Montessori approach on the development of early mathematical abilities, specifically arithmetic skills, in young children. The results of this study provide significant insight into how Montessori methods contribute to the improvement of counting and numerical comprehension among preschool-aged children. This research stands out by quantifying the effect size of this impact using robust statistical tools such as Cohen's d, Hedges' correction, and Glass's delta. The study reveals an extremely large effect, suggesting that the Montessori method has a profound influence on children's ability to engage with and understand basic

mathematical concepts. The findings also underscore the importance of hands-on, self-directed learning environments for fostering both academic and emotional growth in young children, reinforcing the foundational role of Montessori education in shaping early childhood education practices. Educators are encouraged to adopt Montessori materials and methods where feasible, adapting activities to local resource availability to maximize benefits for numeracy and psychological health.

Conclusion

This study demonstrates that the Montessori method significantly enhances early childhood numeracy skills, such as counting, number comprehension, and classification. The hands-on, experiential learning approach with concrete materials not only deepens children's understanding of mathematics but also supports their psychological development, reducing anxiety and boosting self-confidence. The findings emphasize the importance of an experiential learning environment that allows children the freedom to learn independently, contributing to both cognitive and emotional growth. With a very large effect size, this research reinforces the evidence that the Montessori method is an effective approach for improving children's mathematical skills while also supporting their psychological well-being. Despite the small sample and brief intervention, results strongly support Montessori as an effective approach for early numeracy development. Future research should investigate long-term effects with larger samples and explore scalable implementation strategies for diverse educational settings.

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Conflicts of Interest

The authors declare no conflict of interest regarding the publication of this manuscript. In addition, the authors have completed the ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies.

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Author Contributions

Author One contributed to the conceptualization of the study, the original draft, project execution, and visualization of the research. **Author Two** was responsible for the design of the instruments, writing – review & editing, and editing of the manuscript. **Author Three** handled the validation of the research findings, writing – review & editing, and overall supervision of the project.

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