PENA PAUD Journal
Volume 6 Issue 2 (2025) Pages 294-309
ISSN: 2775-4731 (Online) 2777-1377 (Print)
: https://doi.org/10.33369/jpp.v6i2.42328

The Use of *Mathematical Intelligence Stick* Media to Stimulate Number Recognition Skills in Children Aged 5-6 Years

Ani Sartika Sari[1], Kasmiati[2], Winda Sherly Utami [3]✉
anisartikasari0@gmail.com [1], kasmiatijambi963@gmail.com [2], windasherly@unja.ac.id [3]
Early Childhood Education Teacher Education Program, Jambi University, Jambi, Indonesia

Abstract
Mastery of number concepts is a crucial foundation for cognitive development in early childhood, but is often hindered by learning methods that are often abstract and monotonous. This study aims to analyze the effectiveness of the Mathematical Intelligence Stick media in improving number symbol recognition skills in 5-6 year old children at Harapan Bunda Kindergarten. This study applied a quantitative approach with a Pre-Experimental One Group Pretest-Posttest design, involving 15 children selected through saturated sampling techniques. The findings showed a substantial improvement, with the average score of children's abilities increasing sharply from 12.73 in the pretest to 20.46 in the posttest. Effect size analysis using Cohen's d yielded a value of 2.64, indicating a powerful effect. This indicates that the integration of manipulative sticks successfully bridges children's understanding from the enactive to the symbolic level, while stimulating fine motor skills. This study concludes that the Mathematical Intelligence Stick is an effective pedagogical tool for fostering concrete, interactive, and meaningful mathematics learning in early childhood.

Keywords: Mathematical Intelligence, stick media, number symbol recognition ability, early childhood education, numeracy, manipulative learning.

How to cite this article:
Sari, A. S., Kasmiati, & Utami, W. S. (2025). The Use of Mathematical Intelligence Stick Media to Stimulate Number Recognition Skills in Children Aged 5-6 Years. *JURNAL PENA PAUD*, *6*(2), 294–309. https://doi.org/10.33369/jpp.v6i2.42328

✉ Corresponding author:
Email Address: anisartikasari0@gmail.com(**Ani Sartika Sari**)
Published: Bengkulu University
Received 05 June 2025, Accepted 23 December 2025, Published 30 December 2025

INTRODUCTION

Early childhood education provides an important foundation for shaping cognitive abilities, particularly by fostering early mathematical concepts that influence academic success at subsequent levels (Clements & Sarama, 2021). The ability to recognize number symbols in children aged 5-6 years is a crucial indicator of cognitive development, as it underpins understanding of numeracy concepts and simple mathematical operations (Dyson et al., 2013). Children experience difficulties connecting numerical symbols to concrete quantities, resulting in low numeracy literacy at the elementary school level (Purpura et al., 2017).

Early mathematics is an aspect of cognitive development that has long-term implications for children's future academic success. The ability to recognize number symbols is a fundamental component of early childhood mathematics learning, as it bridges understanding of concrete quantities with abstract symbolic representations (Eka Daryati & Sadiana, 2025; Nguyen et al., 2016). Children aged 5-6 years are in a critical phase of cognitive development, during which they begin to form mental schemas that map numerical symbols to their quantitative meanings. Mastering this skill not only facilitates learning basic arithmetic operations but also lays the foundation for logical thinking and problem-solving that will continue to develop throughout their lives.

Initial observations conducted by researchers at the Harapan Bunda Kindergarten in Kubu Kandang Village, Pemayung District, revealed several problems in the recognition of number symbols. Most children had difficulty when asked to match number symbols with concrete objects, especially for numbers greater than ten. Many children were unable to sequence numbers correctly and consistently, often skipping numbers or reversing the order of specific numbers. A concerning phenomenon was the tendency for children to memorize the visual form of numbers without understanding the quantity they represent. When the teacher asked the children to show the number of objects corresponding to a given number, many appeared confused and gave incorrect answers.

The problems encountered in the field are consistent with the findings of previous studies. According to Szűcs et al (2013), difficulties in recognizing number symbols are closely related to weaknesses in visual-spatial memory and inhibitory abilities in children. Another study by Pitchford et al (2016) found that fine motor skills and concrete manipulative experiences play a significant predictive role in children's mathematical abilities in the early years of primary education. Knowledge of numbers, not just numerical estimation skills, is a determining factor in children's arithmetic development. Many mathematics learning practices in early childhood education still rely on conventional approaches and do not optimize kinesthetic and visual learning modalities simultaneously (Daryati, 2025; Göbel et al., 2014).

Some studies have explored the use of innovative learning media to enhance young children's understanding of number concepts, finding that mathematical manipulatives designed with cognitive science principles can significantly improve children's mental representations of numbers. This indicates that spatial construction activities with blocks are positively associated with children's early mathematical skills (Laski et al., 2015; Verdine et al., 2014). Research by Ramani & Siegler (2014) shows that linear board games effectively improve children's numerical knowledge across diverse backgrounds. The use of number blocks improves children's cognitive abilities, while flashcards are effective in introducing number concepts. The media generally address only one or two aspects of children's intelligence and do not adopt a holistic, multiple-intelligences approach (Masniladevi et al., 2020; Puspitasari & Rakimahwati, 2021).

The theory of multiple intelligences, developed by Howard Gardner, provides an important theoretical basis for understanding that each child has a unique and diverse intelligence profile. (Shearer & Karanian, 2017). Logical-mathematical intelligence is one dimension of intelligence that can be stimulated and developed through appropriate learning approaches. Mathematical intelligence includes the ability to use numbers effectively, recognize patterns and relationships, think logically, and understand cause-and-effect principles (Chandratika, 2025; Vogt et al., 2018). Preschoolers' understanding of mathematical language is strongly related to their specific numeracy skills. In this study, the researchers set the use of the Mathematical Intelligence Stick Media as the independent variable, while the ability to recognize number symbols was used as the dependent variable, which was measured through three leading indicators, namely the ability to name number symbols, match symbols with the number of objects, and sort numbers systematically (Fadillah & Suryadi, 2025; Hornburg et al., 2018).

The innovation in this study is the development of the Mathematical Intelligence Stick Media, designed to integrate principles of cognitive neuroscience and multiple intelligences theory. This media consists of colored wooden sticks of various sizes representing numerical values, equipped with different textures to provide sensory stimulation, and can be arranged in various patterns and configurations that are attractive to children. The design of this media adopts a concrete-representational-abstract step-by-step learning approach that has been proven effective in building mathematical conceptual understanding (Eka Daryati & Sadiana, 2025). The learning design is based on an accurate understanding of how children's brains process information, showing that experiences with diverse spatial and numerical representationscan accelerate the development of children's understanding of numbers (Howard-Jones, 2014; Mix, 2019).

Research gaps are clearly identified in the existing literature. First, there is still very limited development of mathematics learning media specifically designed according to multiple intelligences principles for children aged 5-6 years, particularly in Indonesia (Merkley & Ansari, 2016). Second, no media have been found that systematically integrate the sensory-motor, visual-spatial, and logical-mathematical modalities into a cohesive, comprehensive learning tool (Zhang et al., 2020). Third, Purpura et al. (2017) found that although the ability to recognize number symbols is a strong predictor of long-term mathematical success, evidence-based interventions available to early childhood educators remain very limited.

This study has dual dimensions that complement each other. From a practical perspective, early childhood educators need alternative learning media that are not only visually appealing but also pedagogically effective in developing children's mathematical understanding. From a theoretical perspective, this study aims to address the knowledge gap regarding how manipulatives grounded in multiple intelligences can be optimized for early mathematics learning within the context of Indonesian culture and the education system (Kurniati et al., 2021).

Based on the background described above, the purpose of this study is to analyze the effectiveness of using the Mathematical Intelligence Stick Media in stimulating the ability to recognize number symbols in 5-6-year-old children at the Harapan Bunda Kindergarten in Kubu Kandang Village, Pemayung District. Specifically, this study aims to describe children's initial ability to recognize number symbols prior to the implementation of the media, systematically implement the Mathematical Intelligence Stick Media in mathematics instruction, and measure the increase in children's ability to recognize number symbols after using the media.

METHODOLOGY

Type and Design of Research

This research used a quantitative approach with a quasi-experimental method (pre-experimental design). The research design used was a One Group Pretest-Posttest Design, in which the research was conducted on only one group without a comparison group. s were administered twice: before the treatment (pretest) and after the treatment (posttest). This design was chosen to determine the effect of using the Mathematical Intelligence Stick media on children's ability to recognize number symbols. The research design pattern is described as follows:

O1 - X - O2

Explanation:

O1: Initial test (pretest) before treatment

X: Treatment using the Mathematical Intelligence Stick media

O2: Final test (posttest) after treatment

Time and Place of Research

This research was conducted at Harapan Bunda Kindergarten, located in RT.04, Kubu Kandang Village, Pemayung District, Batanghari Regency, Jambi. The research was conducted on Group B1 in the odd semester of the 2024/2025 academic year with a duration of two months.

Population and Sample

The study population comprised all students in Group B at Harapan Bunda Kindergarten in Kubu Kandang Village. The sampling technique used was total sampling, which involves selecting the entire population as the sample. This was done because the population size was relatively small, namely, less than 30 people. Thus, the sample in this study consisted of 15 students aged 5-6 years.

Data Collection Techniques and Instrument Development

The primary data collection technique used was structured observation. Observations were made to observe the children's ability to recognize number symbols before and after using the media. The research instrument used was an observation sheet (checklist) containing indicators of the ability to recognize number symbols. These indicators included: (1) naming number symbols 1-10; (2) using number symbols to count; and (3) matching numbers with number symbols. Before use, the instrument underwent expert validation (expert judgment) by the supervising lecturer to ensure the suitability of the measuring tool.

Data Analysis Techniques

Data Analysis Techniques: Data analysis was conducted using SPSS. Data analysis techniques included:

1. Prerequisite Analysis Tests: a. Normality Test: Using the Shapiro-Wilk test (given that the sample size is < 50) or the Lilliefors test to determine whether the data is typically distributed. The requirement for data to be normally distributed is that the significance value (Sig.) > 0.05. b. Homogeneity Test: Using the Levene Statistic (Test of Homogeneity of Variances) to determine whether the data variance is homogeneous or not.
2. Hypothesis Test: Use the Paired Sample T-Test to determine the significance of the difference between the pretest and posttest scores. The hypothesis is accepted if the Sig. (2-tailed) value is < 0.05.
3. Effect Size Test: To determine the effectiveness of media use, the Effect Size was calculated using Cohen's d formula.

RESULTS AND DISCUSSION

RESULTS

Validation of the observation instrument by two supervising lecturers confirmed its suitability for assessing 5-6-year-old children's ability to recognize number symbols. The indicators developed pertain to three main cognitive dimensions: identifying numerical symbols, applying them in a counting context, and mapping the relationship between symbols and concrete quantities. Table 1 details the measurement constructs and their operational descriptors.

Table 1. *Pretest* Assessment

Variable	Indicators	Descriptor	No item
Ability to Recognize Number Symbols in Children Aged 5-6 Years	1. Name the number symbols 1-10	1. The child can name number symbols 1-10 in order 2. Children can recognize number symbols 1-10 in random order	1, 2
	2. Using number symbols for counting	3. Children can use number symbols in addition 4. Children can use number symbols in subtraction.	3
	3. Matching numbers with number symbols	5. Children are able to match the number of objects with number symbols 6. Children are able to match number symbols 1-10 with objects	5,6

Pretest observations revealed heterogeneity in pre-numeracy abilities among the research sample. Individual scores ranged from 7 to 17 out of a maximum of 24, reflecting significant variation in conceptual understanding among children. The data in Table 2 show that most children were in the transition phase from concrete quantity understanding to abstract symbolic understanding.

Table 2. *Pretest* Observation Results

No	Subject Initials	Score (Pre-test)	Ideal Score
1	FA	16	24
2	AR	14	24
3	AI	13	24
4	SN	17	24
5	IA	17	24
6	IS	15	24
7	FR	12	24
8	AAI	11	24
9	AAH	11	24
10	AFS	10	24

No	Subject Initials	Score (Pre-test)	Ideal Score
11	AU	9	24
12	WAZ	10	24
13	AA	11	24
14	FN	17	24
15	MA	7	24
Total		191	360
Average		12.73	24
Percentage		53.05%	100

The pretest average score of 12.73 (53.05%) indicates the dominance of a visual memorization approach to number symbols without a deep understanding of quantitative meaning. Analysis by descriptor confirms a pattern of systematic difficulty, particularly in numerical operations. The subtraction aspect showed the lowest level of mastery (36.66%), consistent with cognitive findings that subtraction operations are inherently more complex than addition for preschool-aged children. The relatively higher ability to match symbols to objects (56.66%) indicates that multimodal learning can serve as an effective cognitive bridge. Table 3 provides a comprehensive map of priority intervention areas.

Table 3**.** Average *pretest* distribution per descriptor

No	Indicator Item	Empirical Score	Ideal Score	Percentage
1	The child can name the numerals from 1 to 10 in order.	43	60	71.66
2	Children can recognize number symbols 1-10 in random order.	32	60	53.33
3	Children can use number symbols in addition.	26	60	43.33
4	Children can use number symbols in subtraction.	22	60	36.66
5	Children can match the number of objects to number symbols.	34	60	56.66
6	Children can match number symbols from 1 to 10 to objects.	34	60	56.66
	Total	191	360	
	Percentage	53.05	100	

The implementation of the Mathematical Intelligence Stick as an intervention was designed based on the principles of concrete-representational-abstract learning. A structurally consistent posttest instrument enabled the measurement of measurable cognitive development. Table 4 documents the assessment framework used.

Table 4. *Posttest* Assessment

Variable	Indicator	Descriptor	No item
Ability to Recognize Number Symbols in Children Aged 5-6 Years	1. Name the number symbols 1-10	1. The child can name number symbols 1-10 in order 2. Children can recognize number symbols 1-10 in random order	1, 2
	2. Using number symbols for counting	3. Children can use number symbols in addition 4. Children can use number symbols in subtraction.	3
	3. Matching numbers with number symbols	5. Children are able to match the number of objects with number symbols 6. Children are able to match number symbols 1-10 with objects	5,6

The *posttest* results show a qualitative transformation in numerical understanding. The increase in the average score from 60.7% to 20.46 (85.27%) is not merely a statistical change, but evidence of the consolidation of children's mental schemas in processing numerical information. Table 5 reveals that all subjects made progress, with some children achieving mastery, reflecting the media's potential to accommodate diverse learning rates.

Table 5. *Posttest* Observation Results

No	Subject Initials	Score (Posttest)	Ideal Score
1	FA	24	24
2	AR	20	24
3	AI	19	24
4	SN	23	24
5	IA	23	24
6	IS	21	24
7	FR	21	24
8	AAI	21	24
9	AAH	22	24
10	AFS	21	24
11	AU	17	24
12	WAZ	17	24
13	AA	17	24
14	FN	24	24
15	MA	17	24
Total		**307**	**360**
Average		**20.46**	**24**

Percentage	**85.27**	**100**

Analysis by indicator reveals distinct dynamics in cognitive development. The improvement in the ability to name number sequences (100%) indicates consolidation of verbal and sequential memory. The jump in symbol-quantity matching ability to 90% indicates a strengthening of semantic associations between abstract representations and numerical meanings. The most dramatic improvement occurred in arithmetic operations (average +34.17 percentage points), indicating that the media successfully facilitated the transition from concrete reasoning to relational understanding of numbers. Table 6 visualizes the paradigmatic shift in children's numerical ability profiles.

Table 6. Distribution of *posttest* averages per descriptor

No	Indicator Item	Empirical Score	Ideal Score	Percentage
1	The child can name the numerals for numbers 1-10 in order.	60	60	100
2	Children can recognize number symbols 1-10 in random order.	51	60	85
3	Children can use number symbols in addition.	45	60	75
4	Children can use number symbols in subtraction.	43	60	71.66
5	Children can match the number of objects to number symbols.	54	60	90
6	Children can match the symbols for numbers 1-10 with objects.	54	60	90
	Total	307	360	
	Percentage	85.27%	100	

Graph 1 represents a consistent pattern of development across all domains of ability. The curve showing convergence in achievement across indicators suggests holistic integration of numerical knowledge, in which procedural and conceptual abilities develop simultaneously.

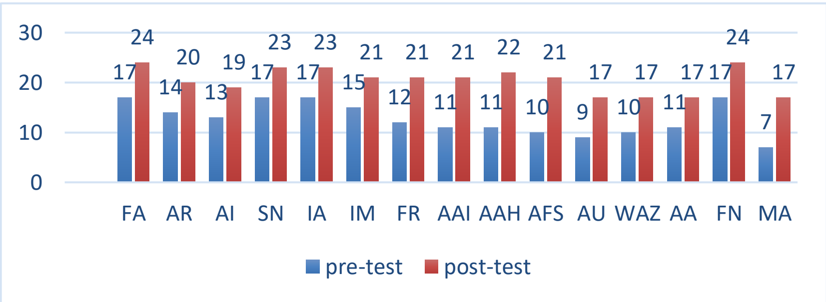

Figure 1**.** Comparison graph of *pretest* and *posttest*

The Shapiro-Wilk normality test confirms that the data distribution meets parametric assumptions. Significance values above 0.05 in both data groups (Table 7) validate the reliability of the measurements and the suitability of the inferential analysis method.

Table **7**. Data Normality Test

Tests of Normality						
	Kolmogorov-Smirnov[a]			*Shapiro-Wilk*		
	Statistic	*df*	*Sig.*	*Statistic*	*df*	*Sig.*
Pretest Results	.170	15	.200*	.914	15	,158
Posttest Results	,183	15	.192	.890	15	,068

Hypothesis testing with *the Paired Sample T-Test* yielded a significance level of 0.000, definitively rejecting the null hypothesis. The Cohen's d effect size of 2.64 indicates that the intervention's influence is very large, exceeding conventional criteria for transformative educational impact. The results in Table 8 not only show statistical differences but also reveal the magnitude of substantive cognitive change.

Table 8. Hypothesis Testing Data

Paired Samples Test									
		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Pre-test Post-test Results - Class	-7.733	1.944	.502	-8.810	-6,657	-15,403	14	,000

Based on the table above, the paired-samples test data were obtained using SPSS. The Sig. value (2-tailed) was 0.001 <0.05, and Ho was rejected, and Hal was accepted. It can be concluded that the use of the mathematical intelligence stick significantly affects 5-6-year-old children's ability to recognize number symbols at Harapan Bunda Desal Kubu Kandangl Kindergarten, Pemayungl District, based on pre-test and post-test data. The research results were obtained from measuring *the effect size* in *the paired test*, using *Cohen's* formula as follows.

$$d = \frac{Posttest\ Average\ Score - Pretest\ Average\ Score}{Standar\ Deviasi}$$

$$= \frac{20{,}46 - 12{,}73}{(3{,}283 + 2{,}560) : 2}$$

$$= \frac{7{,}74}{2{,}92}$$

$$= 2.64$$

The effect size calculated using Cohen's formula for the use of the medial mathematical intelligence stick on the ability to recognize number symbols is 2.46. Meanwhile, the standard interpretation based on the table falls into the category of decisive influence. From a developmental perspective, this medium leverages the sensitive period in 5-6-year-old children for the development *of number sense*. The integration of sensorimotor and visuospatial modalities is consistent with neuroscientific findings on synaptic plasticity in the parietal cortex during numerical processing. The pedagogical implications require a reorientation of early mathematics learning practices from a symbolic transmission approach to knowledge construction through multimodal exploration. This medium provides structured yet flexible scaffolding, enabling differentiated learning according to each child's developmental stage.

DISCUSSION

Based on the data analysis, the results show that the use of the Mathematical Intelligence Stick media has a very significant impact on the ability to recognize number symbols in 5-6-year-old children at Harapan Bunda Kindergarten. The increase in the average score from 12.73 (beginning to develop category) at the pretest to 20.46 (developing very healthy category) at the posttest indicates that the researcher's intervention changed the structure of children's understanding from abstract memorization to concrete understanding.

The effect size (Cohen's d) of 2.64 confirms that the effectiveness of this media is extreme. Interpretively, this success was driven by the characteristics of the stick media, which accommodated children's sensory-motor needs. Early childhood is characterized by the concrete preoperational stage, during which children rely on physical objects to understand abstract concepts such as numbers. Mathematical Intelligence Stick works by visualizing quantities that are often difficult for children to understand when using worksheets alone. When children hold, count, and group sticks, there is synchronization between fine motor activities and cognitive processing in the brain, so that memories of number symbols are stored longer.

The findings in this study align with and reinforce the results of Novianti & Garzia (2020), which found that stick-based media can stimulate symbolic thinking. However, the fundamental difference between this study and the aforementioned study lies in the specification of indicators. This study demonstrates that sticks not only support symbol recognition but also facilitate simple arithmetic operations (addition and subtraction). This also supports the theory of Clements & Sarama (2014), which states that children's learning trajectories in mathematics must begin with concrete, informal experiences.

Furthermore, these results confirm the research (Clements & Sarama, 2021; Laski et al., 2015) which emphasizes the importance of structured manipulative materials. Compared with the conventional methods observed in initial observations (the dominance of blackboards), the use of this medium is consistent with the findings. of Maulina et al (2024) which states that concrete visualization is the key to successful early numeracy literacy. This study fills the gap mentioned by Purpura et al (2013) regarding children's difficulty in connecting numerical symbols with quantities, proving that physical bridges (sticks) are an effective solution to this problem.

The practical implication of these findings is the urgency for early childhood educators to reform mathematical teaching aids in the classroom. Teachers can no longer rely solely on songs or number posters. The use of Mathematical Intelligence Sticks offers a scaffolding strategy where children learn gradually: from holding objects (enactive), seeing images/symbols on sticks (iconic), to understanding written numbers (symbolic).

Theoretically, this research provides empirical evidence for Howard Gardner's Multiple Intelligences theory, particularly in the logical-mathematical and kinesthetic domains. The implication is that mathematics learning design in early childhood education must be multisensory. Schools need to allocate a budget or encourage teachers' creativity to develop safe and engaging manipulative media, as evidence shows that investment in concrete learning media is directly correlated with children's cognitive achievement.

Despite showing positive results, this study has several limitations that need to be acknowledged. First, the use of a one-group pretest-posttest design without a control group makes internal validity somewhat vulnerable to external factors (e.g., natural maturation or at-home learning) that may contribute to score increases, even though statistical tests are highly significant.

Second, the small sample size (15 children) and the single kindergarten setting limit the generalizability of these results to broader populations or different cultural contexts. Third, the relatively short duration of the intervention may not have been sufficient to assess children's long-term retention (memory) of number concepts after treatment discontinuation.

This study paves the way for the development of a more inclusive and enjoyable model of mathematics learning. In the future, this media model can be developed by integrating technologies (such as Augmented Reality on sticks) to adapt to the digital age without sacrificing its manipulative aspects. Further studies are recommended that use the True Experimental method and include a control group to yield more robust results. In addition, future researchers can expand the dependent variables beyond number-symbol recognition to include simple mathematical problem-solving skills and examine the effectiveness of this medium for children with special needs who may have visual-spatial processing difficulties.

CONCLUSION

Based on the data analysis and discussion, it can be concluded that the use of the Mathematical Intelligence Stick media has a significant positive effect on children's ability to recognize number symbols in the 5-6 age range. The sharp increase in average scores and strong effect sizes demonstrate that this medium is effective in shifting children's learning patterns from abstract memorization to concrete conceptual understanding. This intervention effectively engages both cognitive and motor components, making numeracy learning more meaningful. Thus, this manipulative media is highly recommended for early childhood education practitioners as a strategic tool to strengthen children's basic mathematical foundations in a fun and interactive learning environment.

REFERENCES

Chandratika, I. (2025). Effectiveness of Moringa Extract Liquid Supplement on Increasing Children’s Appetite in the Cerdas and Insani Playgroup. *Jurnal Gizi Dan Teknologi Pangan : Nutrismart*, *1*(1), 36–51. https://doi.org/10.64146/3483vp48

Clements, D. H., & Sarama, J. (2014). *Learning and teaching early math: The learning trajectories approach*. Routledge. https://doi.org/10.4324/9780203883389

Clements, D. H., & Sarama, J. (2021). *Learning and Teaching Early Math: The Learning Trajectories Approach* (3rd ed.). Routledge.

Daryati, M. (2025). The Effectiveness of Interactive Learning Media in Improving Early Childhood Numeracy Skills. *JURNAL PENA PAUD*, *6*(1), 1–13. https://doi.org/10.33369/jpp.v6i1.41166

Dyson, N. I., Jordan, N. C., & Glutting, J. (2013). A number sense intervention for low-income kindergartners at risk for mathematics difficulties. *Journal of Learning Disabilities*, *46*(2), 166–181. https://doi.org/10.1177/0022219411410233

Eka Daryati, M., & Sadiana, M. (2025). The Influence of Cooking Activities on the Introduction of Healthy Food for Early Childhood Education. *HealthSmart: Jurnal Kesehatan Masyarakat*, *1*(1), 14–26. https://doi.org/10.64146/1js56e90

Fadillah, & Suryadi, D. (2025). The Relationship Between Parenting Patterns and Balanced Nutritional Intake with Nutritional Status of Young Children. *HealthSmart: Jurnal Kesehatan Masyarakat*, *1*(1), 52–65. https://doi.org/10.64146/7g6t1b06

Göbel, S. M., Watson, S. E., Lervåg, A., & Hulme, C. (2014). Children's arithmetic development: It is number knowledge, not the approximate number sense, that counts. *Psychological Science*, *25*(3), 789–798. https://doi.org/10.1177/0956797613516471

Hornburg, C. B., Schmitt, S. A., & Purpura, D. J. (2018). Relations between preschoolers' mathematical language understanding and specific numeracy skills. *Journal of Experimental Child Psychology*, *176*, 84–100. https://doi.org/10.1016/j.jecp.2018.07.005

Howard-Jones, P. A. (2014). Neuroscience and education: Myths and messages. *Nature Reviews Neuroscience*, *15*(12), 817–824. https://doi.org/10.1038/nrn3817

Kurniati, E., Nur Alfaeni, D. K., & Andriani, F. (2021). Analisis Peran Orang Tua Dalam Mendampingi Anak di Masa Pandemi Covid-19. *Obsesi: Jurnal Pendidikan Anak Usia Dini*, *5*(1), 241–256. https://doi.org/10.31004/obsesi.v5il.541

Laski, E. V, Jor'dan, J. R., Daoust, C., & Murray, A. K. (2015). What makes mathematics manipulatives effective? Lessons from cognitive science and Montessori education. *SAGE Open*, *5*(2), 1–8. https://doi.org/10.1177/2158244015589588

Masniladevi, M., Anggraini, V., & Murni, A. (2020). Meningkatkan kemampuan kognitif anak melalui media balok angka di taman kanak-kanak. *Jurnal Pendidikan Tambusai*, *4*(3), 2539–2549. https://doi.org/10.31004/jptam.v4i3.737

Maulina, A. Q., Habibi, M., Rachmayani, I., & Suarta, I. N. (2024). Meningkatkan Kemampuan Mengenal Lambang Bilangan Melalui Penggunaan Kartu Angka Dan Kartu Gambar Pada Anak Usia Dini. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, *9*(3), 392–400. https://doi.org/10.23969/jp.v9i3.12876

Merkley, R., & Ansari, D. (2016). Why numerical symbols count in the development of mathematical skills. *Current Opinion in Behavioral Sciences*, *10*, 14–20. https://doi.org/10.1016/j.cobeha.2016.04.006

Mix, K. S. (2019). Why are spatial skill and mathematics related? *Child Development Perspectives*, *13*(2), 121–126. https://doi.org/10.1111/cdep.12323

Nguyen, T., Watts, T. W., Duncan, G. J., Clements, D. H., Sarama, J., Wolfe, C., & Spitler, M. (2016). Which preschool mathematics competencies are most predictive of fifth grade achievement? *Early Childhood Research Quarterly*, *36*, 550–560. https://doi.org/10.1016/j.ecresq.2016.02.003

Novianti, R., & Garzia, M. (2020). Penggunaan Gadget Pada Anak; Tantangan Baru Orang Tua Milenial. *Jurnal Obsesi Jurnal Pendidikan Anak Usia Dini*. https://doi.org/10.31004/obsesi.v4i2.490

Peltier, C., & Vannest, K. J. (2018). Using the concrete representational abstract (CRA) instructional framework for mathematics with students with emotional and behavioral disorders. *Preventing School Failure*, *62*(2), 73–82. https://doi.org/10.1080/1045988X.2017.1354809

Pitchford, N. J., Papini, C., Outhwaite, L. A., & Gulliford, A. (2016). Fine motor skills predict maths ability better than reading ability. *Frontiers in Psychology*, *7*, 783. https://doi.org/10.3389/fpsyg.2016.00783

Purpura, D. J., Baroody, A. J., & Lonigan, C. J. (2013). The transition from informal to formal mathematical knowledge: Mediation by numeral knowledge. *Journal of Educational Psychology*, *105*(2), 453. https://doi.org/10.1037/a0031753

Purpura, D. J., Schmitt, S. A., & Ganley, C. M. (2017). Foundations of mathematics and literacy: The role of executive functioning. *Journal of Experimental Child Psychology*, *153*, 15–34. https://doi.org/10.1016/j.jecp.2016.08.010

Puspitasari, E., & Rakimahwati, R. (2021). Pengembangan media flashcard untuk meningkatkan kemampuan mengenal konsep bilangan anak usia dini. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, *6*(2), 1045–1054. https://doi.org/10.31004/obsesi.v6i2.1672

Ramani, G. B., & Siegler, R. S. (2014). How informal learning activities can promote children's numerical knowledge. In R. Cohen Kadosh & A. Dowker (Eds.), *The Oxford handbook of numerical cognition* (pp. 1135–1154). Oxford University Press.

Shearer, C. B., & Karanian, J. M. (2017). The neuroscience of intelligence: Empirical support for the theory of multiple intelligences? *Trends in Neuroscience and Education*, *6*, 211–223. https://doi.org/10.1016/j.tine.2017.02.002

Szűcs, D., Devine, A., Soltesz, F., Nobes, A., & Gabriel, F. (2013). Developmental dyscalculia is related to visuo-spatial memory and inhibition impairment. *Cortex*, *49*(10), 2674–2688. https://doi.org/10.1016/j.cortex.2013.06.007

Verdine, B. N., Golinkoff, R. M., Hirsh-Pasek, K., Newcombe, N. S., Filipowicz, A. T., & Chang, A. (2014). Deconstructing building blocks: Preschoolers' spatial assembly performance relates to early mathematical skills. *Child Development*, *85*(3), 1062–1076. https://doi.org/10.1111/cdev.12165

Vogt, F., Hauser, B., Stebler, R., Rechsteiner, K., & Urech, C. (2018). Learning through play–pedagogy and learning outcomes in early childhood mathematics. *European Early Childhood Education Research Journal*, *26*(4), 589–603. https://doi.org/10.1080/1350293X.2018.1487160

Zhang, X., Räsänen, P., Koponen, T., Aunola, K., Lerkkanen, M. K., & Nurmi, J. E. (2020). Knowing, applying, and reasoning about arithmetic: Roles of domain-general and numerical skills in multiple domains of arithmetic learning. *Developmental Psychology*, *56*(3), 484–500. https://doi.org/10.1037/dev0000864