Bunayya : Jurnal Pendidikan Anak
Volume 12 Issue 1 (2026) Pages 88-106
ISSN: 2460-4437, E-ISSN 2549-3329 (Online)
DOI. http://dx.doi.org/10.22373/bunayya.v12i1.34251

THE EFFECTIVENESS OF "COUNTING BALL SORTING" EDUCATIONAL GAME IN ENHANCING CHILDREN'S NUMERACY SKILLS

Yuriska Haryanti[1*], Denok Dwi Anggraini[2]
[1,2]Pendidikan Islam Anak Usia Dini, Universitas Islam Negeri Madura
Email: yuriskaharyanti@gmail.com

Abstrak
Kemampuan berhitung merupakan fondasi penting dalam perkembangan kognitif anak usia dini dan menjadi indikator kesiapan memasuki pendidikan dasar. Penelitian ini bertujuan untuk menganalisis efektivitas permainan edukatif Counting Ball Sorting dalam meningkatkan kemampuan berhitung anak usia 4–5 tahun (kelompok A TK) di TK Darul Ulum Sumur Dalam Tamberu Agung. Kemampuan berhitung yang diukur meliputi indikator mengenal simbol angka, menghitung jumlah benda, melakukan korespondensi satu-satu, serta mencocokkan bilangan dengan kuantitas. Penelitian ini menggunakan pendekatan kuantitatif dengan desain *pre-experimental design* model *one group pretest–posttest.* Subjek penelitian berjumlah 20 anak yang ditentukan melalui teknik *total sampling*. Analisis data dilakukan menggunakan statistik deskriptif dan uji *paired sample t-test* setelah memenuhi uji prasyarat normalitas. Hasil analisis menunjukkan adanya peningkatan kemampuan berhitung yang signifikan secara statistik ($p < 0,05$) dengan nilai effect size (Cohen's $d = 3,79$) dalam kategori sangat besar. Temuan ini menunjukkan bahwa aktivitas menyortir dan mencocokkan bola berdasarkan jumlah dan warna secara konkret efektif dalam menstimulasi pemahaman hubungan antara simbol angka dan kuantitas. Kebaruan penelitian ini terletak pada integrasi aktivitas penyortiran (sorting) sebagai strategi kognitif yang memadukan stimulasi numerasi dan koordinasi motorik halus dalam satu desain permainan manipulatif sederhana yang kontekstual pada lembaga PAUD pedesaan. Secara praktis, hasil penelitian ini memberikan implikasi bahwa penggunaan permainan edukatif berbasis aktivitas konkret dapat menjadi alternatif strategi pembelajaran numerasi yang lebih interaktif, bermakna, dan sesuai dengan karakteristik perkembangan anak usia dini.

Kata Kunci: *Counting Ball Sorting*, *Efektivitas, Kemampuan Berhitung*

Abstract
Counting skills constitute an essential foundation in early childhood cognitive development and serve as an important indicator of school readiness. This study aims to analyze the effectiveness of the Counting Ball Sorting educational game in improving counting skills among children aged 4–5 years (Kindergarten Group A) at TK Darul Ulum Sumur Dalam Tamberu Agung. The counting skills assessed include recognizing number symbols, counting objects, performing one-to-one correspondence, and matching numbers with quantities. This research employed a quantitative approach using a pre-experimental design with a one group pretest–posttest model. The participants consisted of 20 children selected through total sampling. Data were analyzed using descriptive statistics and a paired sample t-test after meeting the normality assumption. The results revealed a

statistically significant improvement in children's counting skills ($p < 0.05$), with a very large effect size (Cohen's $d = 3.79$). These findings indicate that hands-on sorting and matching activities based on quantity and color effectively stimulate children's understanding of the relationship between number symbols and quantities. The novelty of this study lies in integrating sorting activities as a cognitive strategy that combines numeracy stimulation and fine motor coordination within a simple manipulative game design implemented in a rural early childhood education context. Practically, the results of this research imply that the use of educational games based on concrete activities can become an alternative strategy for numeracy learning that is more interactive, meaningful, and appropriate to the developmental characteristics of early childhood.

Keywords: *Counting ball sorting, Effectiveness, Numeracy skills*

Corresponding author :
Email Address : yuriskaharyanti@gmail.com
Received 19 February 2026, Accepted 10 March 2026, Published 16 March 2026

A. INTRODUCTION

Numeracy literacy encompasses more than just the fundamental skills of reading numbers and performing basic arithmetic. It represents a multifaceted competency that enables children to cultivate critical thinking, creativity, and collaborative skills. These cognitive attributes are essential for empowering children to effectively navigate and solve practical problems encountered in their daily lives.[1] Globally, an extensive body of educational research indicates that the mastery of numerical concepts during the preschool years is strongly correlated with subsequent academic achievement. For children aged 4-5, numeracy encompasses not only the ability to rote count but also the comprehension of quantitative concepts, the association of symbols with concrete objects, pattern recognition, and basic classification. Consequently, numeracy stimulation must be delivered through pedagogical approaches that align with children's developmental characteristics.

The primary objective of cognitive development is to enhance thinking skills by enabling children to formulate diverse problem-solving strategies, sharpen mathematical reasoning, grasp concepts of space and time, and

[1] Hidayah Hidayah, Joko Sutarto, and Kurotul Aeni, 'Pembelajaran Literasi Numerasi Anak Usia Dini Berbasis Kemitraan Keluarga di PAUD', *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, 7.4 (2023), p. 4432 https://doi.org/10.31004/obsesi.v7i4.4692

deepen their understanding of numerical principles. These competencies aim to empower children to perform categorization and foster a foundation for meticulous and analytical thinking.[2]

In Indonesia, the development of early childhood numeracy is integrated into the National Standards for Early Childhood Education (*Standar Nasional PAUD*), as mandated by the *Kurikulum Merdeka* (Independent Curriculum). According to the Decree of the Head of the Agency for Standards, Curriculum, and Education Assessment No. 009/H/KR/2022, children aged 4–5 are expected to recognize numerical symbols, recite number sequences, and correspond quantities of physical objects with their respective symbols.[3]

However, empirical evidence suggests a discrepancy between policy and practice. Many children continue to struggle with grasping concrete quantitative concepts, particularly when instruction relies on conventional methods—such as rote lectures and static worksheets—that lack manipulative activities. This pedagogical gap highlights an urgent need for innovative, interactive learning media that aligns with children's cognitive developmental stages.

Theoretically, children aged 4–5 reside within the preoperational stage of cognitive development. According to Jean Piaget, during this phase, children's thought processes are characterized by a transition from sensorimotor actions to symbolic representation, yet their reasoning remains predominantly concrete and bound to immediate perception. At this stage, while children begin to use language and mental images to represent the world, they still require tangible, physical interactions to

[2] Lisa, 'Prinsip dan Konsep Permainan Matematika Bagi Anak Usia Dini', *Bunayya: Jurnal Pendidikan Anak*, 3.1 (2017), p. 96.

[3] Badan Standar, Kurikulum, dan Asesmen Pendidikan, *Keputusan Kepala Badan Standar, Kurikulum, dan Asesmen Pendidikan Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Nomor 009/H/KR/2022 tentang Dimensi, Elemen, dan Subelemen Profil Pelajar Pancasila pada Kurikulum Merdeka* (Jakarta: Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi, 2022).

internalize abstract concepts such as quantity and logical sequencing.[4]

Jean Piaget formulated a comprehensive theory of cognitive development in children. Within the context of numeracy and mathematical acquisition, Piaget delineated several developmental stages, most notably the Preoperational Stage (ages 2–7). During this period, children begin to employ symbols and semiotic functions—such as language and mental imagery—to represent physical objects and abstract ideas. Furthermore, children at this stage initiate a foundational understanding of quantity and cardinality, although their comprehension remains fluid and has not yet achieved a fully concrete operational consistency.[5]

Children internalize concepts through direct experience and the manipulation of concrete objects. This pedagogical principle aligns with Jerome Bruner's Theory of Representation, specifically the enactive stage, which underscores the critical role of active learning or learning by doing. [6] Furthermore, Lev Vygotsky's concept of the Zone of Proximal Development (ZPD) elucidates that social interaction and instructional scaffolding within play-based activities can facilitate children in reaching their optimal level of cognitive development.[7] Consequently, numeracy instruction should ideally be designed through educational games that integrate concrete activities and promote children's active participation.

The Montessori approach facilitates a learning environment where children engage through concrete and manipulative activities tailored to their specific developmental stages. Within a Montessori-prepared environment, children are granted the

[4] Jean Piaget, *The Psychology of the Child* (New York: Basic Books, 2019), p. 50.
[5] R. A. Agustina and Radiansyah, 'Meningkatkan Kemampuan Kognitif Dalam Mengenal Lambang Bilangan Menggunakan Model Make a Match Dengan Media Kartu Angka', *Jurnal Inovasi, Kreatifitas Anak Usia Dini (JIKAD)*, 3.1 (2023), p. 9 https://doi.org/10.20527/jikad.v3i1.7708

[6] Jerome S. Bruner, *Toward a Theory of Instruction* (Cambridge, MA: Harvard University Press, 2016), p. 21.
[7] Lev S. Vygotsky, *Mind in Society: The Development of Higher Psychological Processes* (Cambridge, MA: Harvard University Press, 2018), p. 84.

autonomy to select activities involving didactic materials and to complete tasks independently within a structured framework.[8]

Counting ability represents a foundational numeracy skill that necessitates development during early childhood, as it serves as the cornerstone for subsequent mathematical proficiency. Early numeracy encompasses the capacity to recognize numerical symbols, enumerate objects, comprehend quantitative concepts, and apply the principle of one-to-one correspondence within the counting process. These competencies evolve through concrete experiences and children's interactions with tangible objects, as well as through meaningful, play-based activities. Extensive prior research demonstrates that the traditional game of *Congklak* is highly effective for early childhood education, as it significantly enhances numeracy skills. Following engagement with *Congklak*, children exhibit an improved capacity to recognize and write numerical symbols, as well as calculate their scores within the game. These findings suggest that game-based interventions facilitate a more intuitive grasp of arithmetic operations through repetitive, goal-oriented play.[9]

Moreover, both traditional and educational games serve as effective vehicles for cultivating fundamental mathematical skills, including classifying, matching, and sequencing objects—all of which are pivotal to a child's numeracy development.[10] Furthermore, existing studies predominantly focus on media development or the conceptual design of games, often overlooking the empirical evaluation of a specific

[8] Mochammad Ronaldy Aji Saputra and Suryadi Soekardjo, 'Konseling Gaya Belajar Peserta Didik Berdasarkan Teori VARK dan Implementasinya dalam Pembelajaran Berdiferensiasi', *Sociocouns: Journal of Islamic Guidance and Counseling*, 3.2 (2023), p. 171 https://doi.org/10.35719/sjigc.v3i2.120

[9] Yuliana and Dwi Rahmawati, 'Pengaruh Permainan Edukatif terhadap Kemampuan Berhitung Anak', *Jurnal Pendidikan Anak Usia Dini Undiksha*, 9.3 (2021), p. 340 https://doi.org/10.23887/paud.v9i3.37452

[10] Sema Öngören and Serhat Gündoğdu, 'Mathematical Skills in Traditional Children's Games in Early Childhood', *Kastamonu Education Journal*, 29.5 (2021), p. 1052 https://doi.org/10.24106/kefdergi.735687

game's effectiveness in enhancing children's numeracy skills within the practical constraints of an early childhood classroom. In fact, manipulative play involving concrete activities—such as counting and classifying physical objects—holds significant potential to facilitate a more tangible and meaningful grasp of numerical concepts.

Conversely, games that integrate counting and sorting activities serve as vital cognitive stimulation for early numeracy development, as they facilitate the mastery of quantity concepts, classification, and the correspondence between numerical symbols and concrete objects. However, studies specifically examining the effectiveness of educational games based on counting and sorting using tangible media—such as colored balls—remain scarce in early childhood education research, particularly concerning children aged 4–5 within rural school contexts. Furthermore, there is a lack of quantitative experimental research systematically testing the impact of such media on enhancing children's numeracy skills. This situation highlights a significant research gap; while existing literature predominantly explores digital educational games or generalized mathematical play, there is limited empirical focus on simple manipulative games centered on counting and sorting. Consequently, research investigating the combination of these concrete activities as a primary strategy for early numeracy instruction remains underdeveloped.

Therefore, an investigation into the effectiveness of the "Counting Ball Sorting" educational game is imperative to provide empirical evidence on how simple manipulative play can serve as an effective instructional medium for enhancing early childhood numeracy skills.

The novelty of this research lies in its empirical evaluation of the "Counting Ball Sorting" educational game as a foundational numeracy learning medium. This study uniquely integrates the dual activities of counting and sorting within a single, streamlined manipulative game that is both pedagogically sound and

contextually relevant for early childhood learners.

To date, the majority of research concerning early numeracy instruction has predominantly focused on conventional pedagogical media, static worksheets, or digital-based educational games. Conversely, empirical studies that specifically utilize concrete manipulative games—which integrate counting and classification activities within a single, structured play format—remain relatively scarce.

The novelty of this research lies in its integrated and multi-sensory approach to early numeracy, specifically through the introduction of the "Counting Ball Sorting" educational game. Unlike conventional media that often focus on isolated skills, this manipulative game uniquely harmonizes two cognitive processes—quantifying objects and categorizing them based on specific attributes—within a single, systematic framework. By utilizing colored balls as tangible media, the game facilitates a direct and meaningful comprehension of numerical symbols and quantities, offering a practical yet pedagogically sound alternative for early childhood education settings. Furthermore, this study advances the "learning through play" paradigm by concurrently engaging motor, visual, and cognitive activities, thereby transforming abstract mathematical concepts into a concrete, active, and contextual learning experience that surpasses the efficacy of traditional, abstract instructional methods.

Beyond the development of the educational game itself, the primary significance of this study lies in the empirical evaluation of its effectiveness in enhancing early childhood numeracy skills. Consequently, this research provides scientific validation regarding the extent to which simple manipulative play can be implemented as an effective pedagogical strategy for numeracy instruction in early childhood education (ECE) settings.

In light of these aspects, this study offers a novel contribution to the field of early childhood education, specifically through the development of an integrated manipulative-based

educational game designed to enhance foundational numeracy skills in young children. Preliminary observations at Darul Ulum Sumur Dalam Tamberu Agung Preschool revealed that several children in Group A continue to face challenges in recognizing numerical symbols, grasping quantity concepts, and correlating numbers with concrete objects. The lack of instructional variety and limited use of manipulative media have resulted in diminished enthusiasm and a rapid loss of focus during numeracy activities. To address these issues, an innovative and engaging pedagogical strategy is required, such as the "Counting Ball Sorting" educational game. This intervention involves counting and sorting balls based on color or specific quantities, subsequently matching them with the corresponding numerical symbols. This activity is designed not only to stimulate numerical proficiency but also to enhance concentration, eye-hand coordination, and classification skills.

Based on the aforementioned rationale, this study aims to analyze the effectiveness of the "Counting Ball Sorting" educational game in enhancing the numeracy skills of children aged 4–5 at Darul Ulum Sumur Dalam Tamberu Agung Preschool. This research is expected to provide a theoretical contribution to the development of manipulative-based numeracy instruction and offer practical insights for educators in designing counting activities that are more concrete, interactive, and aligned with the developmental characteristics of early childhood.

B. METHODS

This study employs a quantitative approach utilizing a pre-experimental design, specifically the one-group pre-test post-test model. According to Sugiyono (2019), experimental research is conducted to determine the effect of a specific treatment on a given variable under controlled conditions. This design facilitates a comparison of children's numeracy skills before and after the intervention to measure the effectiveness of the treatment.[11] This

[11] Sugiyono, *Metode Penelitian Pendidikan* (Bandung: Alfabeta, 2023), p. 111.

study adopts a numerical data-based approach as it provides precise, measurable information that can be systematically analyzed through statistical methods. The research utilizes a Pre-experimental Design, specifically the One-Group Pretest-Posttest model. This design was selected to determine the differences in children's numeracy skills before and after the intervention. The specifics of the research design are outlined as follows:

$$O_1 \; X \; O_2$$

Figure 1: One-Group Pretest-Posttest Design Research Framework

The notation for the One-Group Pretest-Posttest design used in this study is defined as follows:

O_1: The pre-test score, representing the initial state of the children's numeracy skills prior to the intervention.

X: The treatment, consisting of the educational intervention using the "Counting Ball Sorting" game.

O_2: The post-test score, representing the children's numeracy skills following the completion of the intervention.

The research population comprised all children aged 4–5 years in Group A at Darul Ulum Sumur Dalam Tamberu Agung Preschool, totaling 20 students (8 males and 12 females). The sampling technique employed was total sampling (saturated sampling), in which the entire population was included in the study due to the limited number of available subjects. This approach ensures that the findings comprehensively represent the specific group under investigation.[12]

The application of total sampling ensures that the data obtained accurately reflects the overall population's condition. By eliminating sampling bias, this method enhances the internal validity of the study, providing a comprehensive representation of the numeracy

[12] Ahmed, 'How to Choose a Sampling Technique and Determine Sample Size for Research: A Simplified Guide for Researchers', *Oral Oncology Reports*, 12 (2024), p. 2 https://doi.org/10.1016/j.oor.2024.100662

proficiency levels within the target group.[13]

Primary data sources were obtained through direct observation of children's activities during the instructional process. Secondary data were sourced from scholarly articles concerning numeracy instruction and educational games, as well as school administrative documents that support the research requirements.

The research instruments consist of structured observation sheets and performance tests. The numeracy skill observation sheet was developed based on early numeracy development indicators for children aged 4–5 years, in accordance with the Ministry of Education and Culture Regulation (Permendikbud) Number 137 of 2014 regarding National Standards for Early Childhood Education.[14] The observation sheet comprises six indicators measured on a four-point developmental scale: Not Yet Developed (BB=1), Starting to Develop (MB=2), Developed as Expected (BSH=3), and Very Well Developed (BSB=4).

Table 1: Research Instrument Blueprint for Numeracy Skills

Develop-mental Domain	Indicators	Score/ Level	Definitions
Numeracy Skills	Recognizing Number Concepts	BSB (4)	The child is able to identify/mention numbers 1–10.
		BSH (3)	The child is able to identify/mention numbers 1–7.
		MB (2)	The child is able to identify/mention numbers 1–6.
		BB (1)	The child is able to identify/mention numbers 1-5.
	Identifying various colors	BSB (4)	The child is able to identify and point to 5 colors as requested.

[13] A. Memon, M. A. Thurasamy, H. Ting, and J.-H. Cheah, 'Purposive Sampling: A Review and Guidelines for Quantitative Research', *Journal of Applied Structural Equation Modeling*, 9.1 (2024), p. 9 https://doi.org/10.47263/JASEM.9(1)01

[14] David J. Purpura and Jessica L. Reid, 'Mathematical Language and Early Numeracy Development', *Early Education and Development*, 27.3 (2016), p. 368 https://doi.org/10.1080/10409289.2015.1036346

		BSH (3)	The child is able to identify and point to 4 colors as requested.
		MB (2)	The child is able to identify and point to 3 colors as requested.
		BB (1)	The child is able to identify and point to 2 colors as requested.
	Identifying/ Naming geometric shapes	BSB (4)	The child is able to name 4 different shapes correctly.
		BSH (3)	The child is able to name 3 different shapes correctly.
		MB (2)	The child is able to name 2 different shapes correctly.
		BB (1)	The child is able to name only 1 shape correctly.

The instrument's validity was verified through expert judgment by early childhood education specialists and construct validity testing using the Product Moment correlation with SPSS version 31. Instrument reliability was assessed using Cronbach's Alpha, yielding a coefficient of , which indicates good measurement consistency. Data collection was conducted through participant observation, where the researcher was directly involved in the instructional process to observe and record children's behavior using the observation sheets.[15]

Documentation was conducted by recording instructional activities through photos and videos as supporting data. Data collection took place over five sessions. To control for research bias, specific strategies were implemented as follows: Session 1 served as the pretest; Sessions 2–4 involved the administration of the treatment using the Counting Ball Sorting game (30 minutes per session); and Session 5 served as the posttest. Observation schedules were maintained at consistent times; the researcher utilized a standardized observation protocol and conducted scoring during the posttest data analysis phase.

[15] Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*, 19th edn (Bandung: Alfabeta, 2013), p. 203.

Data analysis was performed using both descriptive and inferential statistics to test the research hypotheses. Descriptive statistics were employed to delineate data characteristics by calculating the mean, standard deviation, and the minimum and maximum scores of both pretest and posttest results.[16]

Inferential statistics were conducted using a paired-sample t-test via SPSS version 31 to examine the differences in numeracy skill scores before and after the intervention. Prior to the t-test, a prerequisite normality test was performed using the Shapiro-Wilk test to ensure the data were normally distributed. The research hypothesis is accepted if the p-value < 0.05, indicating a significant effect of the Counting Ball Sorting game on children's numeracy skills. Additional analysis was performed to identify the numeracy dimensions most affected by the intervention by comparing the scores of each indicator. The entire data analysis process adhered to research ethics, maintaining participant confidentiality and reporting results objectively without data manipulation**.**

Data analysis was performed using descriptive statistics to provide a general overview of the data characteristics, followed by inferential statistics to test the relationships between variables.

C. RESULTS AND DISCUSSION

This research was conducted at TK Darul Ulum Sumur Dalam Tamberu Agung and aimed to evaluate the effectiveness of the "Counting Ball Sorting" educational game in enhancing early childhood numeracy skills. A quantitative approach with a one-group pretest-posttest pre-experimental design was employed, involving a sample of 20 children from Group A. The research subjects participated in classroom learning activities, beginning with a pretest to assess their baseline numeracy skills. Subsequently, the children received a treatment consisting of play-based activities using the Counting Ball

[16] C. Kotronoulas and others, 'An Overview of the Fundamentals of Data Management, Analysis, and Interpretation in Quantitative Research', *Seminars in Oncology Nursing* (2023), p. 3 https://doi.org/10.1016/j.soncn.2023.151398

Sorting game across four instructional sessions, concluding with a posttest to measure the improvement in numeracy skills following the intervention.

The descriptive analysis results demonstrate a clear distinction between the initial and final states of the children's numeracy skills following the Counting Ball Sorting game intervention. The descriptive data for the pretest and posttest scores were collected from 20 children in Group A at TK Darul Ulum Sumur Dalam Tamberu Agung. The pretest mean score was 58,5 (SD = [*X*]), indicating a relatively low baseline for children's early numeracy skills. After five sessions, the mean posttest score increased significantly to 91,2 (SD = [*X*]). The comparison between the pretest and posttest results is visualized in Figure 2 below:

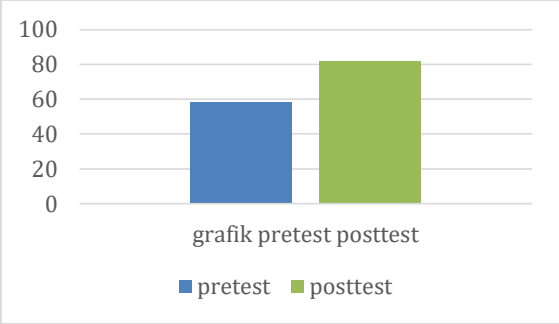

Figure 2. Comparison of Pretest and Posttest Scores

The analysis results revealed a mean difference of 23.50, with a standard deviation of 6.20 and a standard error of the mean of 16.97. The obtained t-value was t (19) = 2,093 with 19 degrees of freedom (df) = 19 and a two-tailed significance value of (2-tailed) = 0,000 < 0,05. The 95% confidence interval showed a difference range between -26.41 and 20.59, which does not include zero, thereby confirming a significant difference. Furthermore, the effect size calculation using Cohen's d yielded a value of d = 3,79 According to Cohen's criteria (d > 0,80), this is categorized as a very large effect, indicating that the Counting Ball Sorting educational game has a highly potent influence on enhancing early childhood numeracy skills.

Based on the statistical test results, the p-value of 0.001, which is significantly lower than the alpha level α 0,05 ndicates a significant difference between the pretest and posttest scores. Consequently, the null hypothesis (H_0) which states that there is no significant effect on the improvement of children's numeracy

skills, is rejected, while the alternative hypothesis (H_a) is accepted. Nevertheless, given that this study employed a pre-experimental one-group pretest-posttest design without a control group, the interpretation of causality must be approached with caution. While the observed improvements can be attributed to the "Counting Ball Sorting" game intervention, the potential influence of confounding factors cannot be entirely ruled out.

This study found a significant difference in children's numeracy skills before and after the implementation of the Counting Ball Sorting educational game. The paired-sample t-test results yielded a significance value of $p < 0,05$, indicating a statistically significant improvement in numeracy proficiency. The posttest mean scores were consistently higher than the pretest scores, demonstrating that the use of concrete play media effectively assists children in understanding number concepts, grouping quantities, and matching numbers with their respective quantities. Furthermore, the very large effect size suggests that the impact of the game is not only statistically significant but also practically robust. These findings indicate that the Counting Ball Sorting educational game serves as an effective instructional strategy aligned with the characteristics of early childhood learners, who thrive through play-based activities and direct hands-on experiences.[17]

Early childhood learning is characterized by concrete, active, and hands-on experiences, which play a vital role in enhancing the understanding of numeracy concepts. Young children grasp early mathematical concepts more easily when directly involved in manipulative activities using real objects. Therefore, the implementation of the 'Counting Ball Sorting' educational game is highly relevant, as it provides opportunities for children to engage in classifying, counting, and matching quantities firsthand. This aligns with the cognitive development

[17] Hijriati, 'Peranan dan Manfaat APE untuk Mendukung Kreativitas Anak Usia Dini', *Bunayya: Jurnal Pendidikan Anak*, 3.2 (2017), p. 62.

of children in the concrete operational stage, which necessitates instructional strategies that avoid abstraction. Learning approaches that rely solely on worksheets or verbal instructions tend to be suboptimal in helping children internalize number concepts.

The findings of this study are consistent with the research by Aisyah, which posits that the use of numeracy-based play media enhances children's numeracy skills through active engagement in learning activities. External factors, such as children's motivation, the teacher's role in facilitating the game, and the learning environment, also influence numeracy development. In other words, despite the high level of effectiveness demonstrated, the generalization of these findings should be approached with caution. By considering the alignment of these results with previous studies, alongside the analysis of research differences and limitations, it can be concluded that the 'Counting Ball Sorting' educational game holds significant potential as an early numeracy instructional strategy. However, further research with more comprehensive designs is necessary to strengthen the external validity of these findings.

The findings of this study are interpreted through the lens of numeracy development theory, which posits that early childhood numeracy encompasses the ability to recognize number symbols, understand quantity concepts, perform one-to-one correspondence, and determine the final count (cardinality).[18] According to Ahmad Susanto, numeracy skills in early childhood are an integral part of cognitive development, fundamentally related to grasping number concepts through concrete activities and direct, real-world experiences.[19] The increase in posttest scores indicates that the 'Counting Ball Sorting' game systematically stimulated numeracy indicators, ranging from number recognition and counting objects to

[18] Douglas H. Clements and Julie Sarama, 'Learning and Teaching Early Math: The Learning Trajectories Approach', *Early Childhood Research Quarterly*, 29.2 (2014), p. 167 https://doi.org/10.1016/j.ecresq.2013.12.005

[19] Susanto, 'Pengembangan Kemampuan Berhitung Anak Usia Dini', *Jurnal Pendidikan Anak*, 10.2 (2021), p. 151 https://doi.org/10.21831/jpa.v10i2.38945

understanding the relationship between symbols and quantities. Consequently, these findings reinforce the theory that early numeracy instruction based on concrete activities is more effective in developing numeracy skills in early childhood.

The theoretical interpretation of these findings suggests that numeracy learning involving manipulative activities—aligned with early childhood developmental characteristics—is more effective than abstract instruction. According to Piaget, children in the pre-operational stage learn most effectively through direct experience with concrete objects. Manipulative activities, such as sorting and counting balls in this game, provide children with the opportunity to actively construct numeracy concepts.[20]

Furthermore, the play-based learning approach is consistent with international research findings, which indicate that play activities can enhance early numeracy skills through active engagement, meaningful contexts, and opportunities for free exploration. For instance, a study by De Chambrier et al. demonstrates that play-based interventions at the kindergarten level are capable of improving children's numeracy, particularly in the aspects of number recognition and the association between symbols and quantities.[21]

The findings of this study also demonstrate that the educational game not only enhances children's numeracy skills statistically but also provides a practical impact on their learning experiences. The children became more motivated, active, and engaged in the learning process, which ultimately supports holistic cognitive development. Implicatively, these results underscore that the use of educational game media, such as 'Counting Ball Sorting', should be integrated as a fundamental part of numeracy instructional strategies in early childhood education. This is

[20] Piaget, 'Piaget's Theory of Cognitive Development Revisited', *Developmental Review*, 6.4 (2022), p. 8 https://doi.org/10.1016/j.dr.2022.101021

[21] Stéphanie De Chambrier, Sylviane L. Zesiger, and Matthieu Baye, 'Impact of a Kindergarten Game-Based Intervention on Early Numeracy Skills', *Early Childhood Research Quarterly*, 56 (2021), p. 1 https://doi.org/10.1016/j.ecresq.2021.02.004

because such media align with children's cognitive development and effectively facilitate meaningful numeracy learning.

D. CONCLUSION

Based on the research findings and data analysis, it can be concluded that the 'Counting Ball Sorting' educational game is effective in enhancing the numeracy skills of early childhood learners at TK Darul Ulum Sumur Dalam Tamberu Agung. The paired-sample t-test results demonstrated a significant difference between pretest and posttest scores, indicating that the treatment had a substantial impact on improving children's numeracy proficiency. This improvement encompasses the ability to recognize number symbols, count objects, and understand the relationship between numbers and quantities through sorting and classifying activities. Furthermore, the very large effect size indicates that the game's influence is not only statistically significant but also practically robust. Consequently, the 'Counting Ball Sorting' educational game is recommended as an effective early numeracy instructional strategy that aligns with the cognitive developmental characteristics of young children, providing a concrete, active, and meaningful learning experience.

REFERENCES

Agustina, A., & Radiansyah, R. (2023). Meningkatkan kemampuan kognitif dalam mengenal lambang bilangan menggunakan model *make a match* dengan media kartu angka. *Jurnal Inovasi, Kreativitas Anak Usia Dini (JIKAD)*, 3(1), 9–16. https://doi.org/10.20527/jikad.v3i1.7708

Ahmed, S. K. (2024). How to choose a sampling technique and determine sample size for research: A simplified guide for researchers. *Oral Oncology Reports, 12*, 1–7. https://doi.org/10.1016/j.oor.2024.100662

Badan Standar, Kurikulum, dan Asesmen Pendidikan, Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi. (2022). *Keputusan Kepala Badan Standar, Kurikulum, dan Asesmen Pendidikan Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Nomor 009/H/KR/2022 tentang dimensi, elemen, dan subelemen profil Pelajar Pancasila pada Kurikulum Merdeka*.

Bruner, J. S. (2016). *Toward a theory of instruction*. Harvard University Press.

Clements, D. H., & Sarama, J. (2014).

Learning and teaching early math: The learning trajectories approach. *Early Childhood Research Quarterly*, *29*(2), 163–173. https://doi.org/10.1016/j.ecresq.2013.12.005

De Chambrier, S., Baye, M., & Zesiger, P. (2021). Impact of a kindergarten game-based intervention on early numeracy skills. *Early Childhood Research Quarterly, 56*, 1–12. https://doi.org/10.1016/j.ecresq.2021.02.004

Hidayah, H., Sutarto, J., & Aeni, K. (2023). Pembelajaran literasi numerasi anak usia dini berbasis kemitraan keluarga di PAUD. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, 7(4), 4431–4440. https://doi.org/10.31004/obsesi.v7i4.4692

Hijriati. (2017). Peranan dan manfaat APE untuk mendukung kreativitas anak usia dini. *Bunayya: Jurnal Pendidikan Anak*, 3(2), 59–69.

Kotronoulas, G., Miguel, S., Dowling, M., Fernández-Ortega, P., Colomer-Lahiguera, S., Bağçivan, G., Pape, E., Drury, A., Semple, C., Dieperink, K. B., & Papadopoulou, C. (2023). An overview of the fundamentals of data management, analysis, and interpretation in quantitative research. *Seminars in Oncology Nursing*, 39(4), 1–9. https://doi.org/10.1016/j.soncn.2023.151398

Lily, N. M., Khotimah, N., & Maarang, M. (2023). Efektivitas permainan tradisional congklak terhadap kemampuan berhitung anak usia dini. *Murhum: Jurnal Pendidikan Anak Usia Dini*, 4(1), 296–303. https://doi.org/10.37985/murhum.v4i1.214

Lisa. (2017). Prinsip dan konsep permainan matematika bagi anak usia dini. *Bunayya: Jurnal Pendidikan Anak*, 3(1), 93–107.

Memon, M. A., Thurasamy, R., Ting, H., & Cheah, J.-H. (2024). Purposive sampling: A review and guidelines for quantitative research. *Journal of Applied Structural Equation Modeling*, 9(1), 1–23. https://doi.org/10.47263/JASEM.9(1)01

Muthoharoh, Riyenil, & Santoso, A. (2019). Pengaruh permainan congklak terhadap kemampuan berhitung anak usia 5–6 tahun di RA Perwanida 04 Sempolan Jember. *JECIE: Journal of Early Childhood and Inclusive Education*, 2(2), 54–63. https://doi.org/10.31537/jecie.v2i2.475

Öngören, S., & Gündoğdu, S. (2021). Mathematical skills in traditional children's games in early childhood. *Kastamonu Education Journal*, 29(5), 1052–1064. https://doi.org/10.24106/kefdergi.735687

Piaget, J. (2019). *The psychology of the child*. Basic Books.

Piaget, J. (2022). Piaget's theory of

cognitive development revisited. *Developmental Review*, 64, 1–11. https://doi.org/10.1016/j.dr.2022.101021

Purpura, D. J., & Reid, J. L. (2016). Mathematical language and early numeracy development. *Early Education and Development*, 27(3), 367–384. https://doi.org/10.1080/10409289.2015.1036346

Saputra, M. R. A., & Soekardjo, S. (2023). Konseling gaya belajar peserta didik berdasarkan teori VARK dan implementasinya dalam pembelajaran berdiferensiasi. *Sociocouns: Journal of Islamic Guidance and Counseling, 3*(2), 167–184. https://doi.org/10.35719/sjigc.v3i2.120

Sugiyono. (2013). *Metode penelitian kuantitatif, kualitatif, dan R&D* (19th ed.). Alfabeta.

Sugiyono. (2023). *Metode penelitian pendidikan*. Alfabeta.

Susanto, A. (2021). Pengembangan kemampuan berhitung anak usia dini. *Jurnal Pendidikan Anak*, 10(2), 145–156. https://doi.org/10.21831/jpa.v10i2.38945

Vygotsky, L. S. (2018). *Mind in society: The development of higher psychological processes*. Harvard University Press.