Addabani: Interdisciplinary Journal of Islamic Education
Vol. 3, No.2, February 2026, DOI: https://doi.org/10.52593/adb.03.2.05
E-ISSN: 3025-6542

LOOSE PARTS MEDIA STRATEGY IN SPURRING CHILDREN'S COGNITIVE DEVELOPMENT IN KOBER CEMPAKA PUTIH

Nurtati Hidayah[1], Soni Samsu Rizal[2], Euis Cici Nurunnisa[3]
Universitas Islam Darussalam Ciamis, Indonesia[1,2,3]
nurtatihidayah@gmail.com,[1] sonisamsurizal@uidc.ac.id.,[2] amangasep99@gmail.com[3]

Received: 21-10-2025 Revised: 19-02-2026 Accepted: 27-02-2026

Abstract
Cognitive development is a fundamental aspect of early childhood education, laying the foundation for future mastery of thinking, reasoning, and problem-solving skills. However, observations indicate that children's numeracy skills in early childhood education institutions remain relatively low due to the dominance of conventional, passive learning. This study aims to improve children's cognitive development, particularly numeracy skills, through the application of loose parts play media such as bottle caps, small stones, used cardboard, and small pieces of wood. The research method used was the Kemmis and McTaggart Classroom Action Research (CAR) model, conducted in two cycles in Kober Cempaka Putih, Pamarican District, Ciamis Regency, from August to September 2025, with 20 children (12 girls and 8 boys) as subjects. Data collection techniques included structured observation, documentation, and field notes, while data analysis used descriptive qualitative and quantitative methods, with percentages of developmental achievements. The results showed significant improvement in each cycle. In the pre-cycle, 35% of children were in the Beginning to Develop (MB) category, and only 20% were in the Very Good Development (BSB) category. After the first cycle, the MB category decreased to 25%, and the BSB category increased to 25%. In the second cycle, there were no more children in the MB category, with 75% of children achieving BSB and 25% in the Developing According to Expectations (BSH) category. These findings confirm that loose parts media effectively improve early childhood numeracy skills while fostering motivation, creativity, and enthusiasm in the learning process.

Keywords: *Cognitive Development, Early Childhood, Loose Parts, Numeracy, Classroom Action Research.*

Perkembangan kognitif merupakan aspek fundamental dalam pendidikan anak usia dini yang berperan sebagai fondasi bagi penguasaan keterampilan berpikir, bernalar, dan pemecahan masalah di masa mendatang. Namun, hasil observasi menunjukkan bahwa kemampuan berhitung anak di lembaga PAUD masih tergolong rendah akibat dominannya pembelajaran konvensional yang kurang melibatkan eksplorasi aktif. Penelitian ini bertujuan untuk meningkatkan perkembangan kognitif anak, khususnya kemampuan berhitung, melalui penerapan media bermain *loose parts* berupa tutup botol, batu kecil, kardus bekas, dan kayu kecil. Metode penelitian yang digunakan adalah Penelitian Tindakan Kelas (PTK) model Kemmis dan McTaggart yang dilaksanakan dalam dua siklus di Kober Cempaka Putih, Kecamatan Pamarican, Kabupaten Ciamis, pada bulan Agustus–September 2025 dengan subjek 20 anak (12 perempuan dan 8 laki-laki). Teknik pengumpulan data menggunakan observasi terstruktur, dokumentasi, dan catatan lapangan, sedangkan analisis data dilakukan secara deskriptif kualitatif dan kuantitatif dengan persentase capaian perkembangan. Hasil penelitian menunjukkan peningkatan signifikan pada setiap siklus. Pada pra-siklus, 35% anak berada pada kategori Mulai Berkembang (MB) dan hanya 20% mencapai

Berkembang Sangat Baik (BSB). Setelah siklus I, kategori MB menurun menjadi 25% dan BSB meningkat menjadi 25%. Pada siklus II, tidak ada lagi anak pada kategori MB, dengan 75% anak mencapai BSB dan 25% pada kategori Berkembang Sesuai Harapan (BSH). Temuan ini mengonfirmasi bahwa media *loose parts* efektif meningkatkan kemampuan berhitung anak usia dini sekaligus menumbuhkan motivasi, kreativitas, dan antusiasme dalam proses pembelajaran.

Kata Kunci: Perkembangan Kognitif, Anak Usia Dini, *Loose Parts*, Kemampuan Berhitung, Penelitian Tindakan Kelas.

INTRODUCTION

Early Childhood Education (PAUD) is a strategic level of education that forms the foundation of holistic child development, covering physical-motor, language, social-emotional, moral-religious, artistic, and cognitive aspects. Law Number 20 of 2003 concerning the National Education System, Article 1, Paragraph 14, defines PAUD as a coaching effort aimed at children from birth to the age of six through educational stimuli to support physical and spiritual growth and development, so that children are ready to enter further education (Ministry of National Education, 2003). Early childhood is often referred to as the *golden age* because during this period, the brain develops rapidly, with about 80% of the human brain's capacity developing between ages 0–6 years (Suyadi, 2014). Therefore, providing the right stimulation at an early age is a critical investment in the success of learning and children's futures.

Among the various aspects of child development, the cognitive aspect receives special attention because it is directly related to the child's ability to think, reason, solve problems, and understand the world around him. Piaget (2013) explained that children's cognitive development progresses through a series of sequential and hierarchical stages, with children aged 2–7 years in the preoperational stage. At this stage, children can use symbols and language to represent objects, but their thinking remains egocentric and intuitive. Vygotsky (in Santrock, 2011) complements this view by emphasizing the role of social interaction and *scaffolding* in *the Zone of Proximal Development* (ZPD) as the main mechanism of children's cognitive development. Meanwhile, Bruner (1966) identified three stages of cognitive representation—enactive, iconic, and symbolic—that affirm the importance of concrete experiences as the starting point for children's learning.

One important indicator of cognitive development in early childhood is early numeracy skills. Based on the Child Development Achievement Level Standard (STPPA) in Permendikbud Number 137 of 2014, numeracy skills are among the aspects of symbolic and logical thinking that must be stimulated from an early age. This ability includes recognizing the concept of numbers, matching the number of objects with the number symbol, counting objects sequentially, and comparing quantities. Longitudinal research by Jordan *et al.* (2009) published in *the Journal of Educational Psychology* found that numeracy skills at an early age are a strong predictor of children's mathematical achievement in elementary school. Similar findings were reported by Duncan *et al.* (2007) in a meta-analysis published in *Developmental Psychology, which found* that early math skills are the strongest predictors of children's academic achievement later in life, surpassing reading and attention skills.

However, the reality on the ground shows that learning practices in many PAUD institutions in Indonesia remain conventional and *teacher-centered*. Numeracy activities are often delivered through verbal explanations or abstract worksheets, which are not aligned with children's stage of cognitive development, who still need concrete experience (Yuliani, 2019). A study by Clements and Sarama (2011), published in *Science,* confirms that effective early childhood mathematics learning must be manipulative, exploratory, and adapted to the child'*s learning trajectory*. The dominant conventional approach actually hinders the development of children's critical thinking skills and creativity. Bredekamp and Copple (2009), in the *Developmentally Appropriate Practice* (DAP) guidelines published by the National Association for the Education of Young Children (NAEYC), emphasize that early childhood learning must be adapted to the level of development, responsive to individual needs, and implemented in the context of meaningful play.

One promising approach to overcome this problem is the use of *loose parts* media in learning. The concept *of loose parts* was first introduced by the architect Simon Nicholson in 1971 through his theory known as *The Theory of Loose Parts*, which states that creativity and invention occur when individuals interact with materials that can be moved, manipulated, and combined freely (Nicholson, 1971). Media *loose parts* are loose materials—both natural, such as stones, twigs, and grains, and artificial, such as bottle caps, pieces of wood, and used cardboard—that are *open-ended, giving* children the freedom to explore and create without rigid end limits.

Numerous studies have examined the effectiveness of *loose parts* in early childhood education. Research by Flannigan and Dietze (2017), published in the *International Journal of Early Childhood Environmental Education,* shows that *loose parts* significantly improve preschoolers' creativity and problem-solving abilities. A study by Maxwell *et al.* (2008) in *Environment and Behavior* revealed that a play environment rich in manipulative materials is positively correlated with children's physical and cognitive activity levels. In the Indonesian context, Astuti (2021) in *the Journal of Obsession: Journal of Early Childhood Education,* indexed by SINTA 2, reported that loose *parts* media can improve early childhood numeracy skills. Meanwhile, Pratiwi and Lestari (2022) in *Cakrawala Dini* found that the *loose parts method* positively affects children's creativity and cognition.

However, previous studies have generally focused on aspects of creativity and divergent thinking, while research that specifically examines the application of *loose parts* to improve numeracy skills through classroom action research designs remains relatively limited. The novelty of this research lies in three main aspects. *First*, the use of *loose parts* materials from the environment around the school (bottle caps, small stones, used cardboard, and small wood) as a contextual and affordable medium for calculation. *Second*, the integration of the group play approach, contextualization through stories, and a simple reward system in the design of actions in cycle II as a reflection-based improvement strategy. *Third*, this research was conducted in non-formal PAUD institutions (Play Groups) in rural areas with limited facilities and infrastructure, so that the research findings have practical relevance for similar contexts.

Based on this background, this study aims to: (1) describe the initial condition of children's numeracy ability in Kober Cempaka Putih before the application of loose *parts media*; (2) describe the process of applying *loose parts media* in improving children's numeracy skills through two cycles of classroom action research; and (3) analyze the improvement of children's cognitive development after the application of loose *parts media*. The results of this study are expected to make a theoretical contribution by strengthening empirical evidence on the effectiveness *of loose parts* in early childhood cognitive development, as well as practical contributions in the form of recommendations for innovative learning strategies for early childhood teachers.

Early Childhood Cognitive Development: A Theoretical Perspective

Cognitive development is a fundamental aspect of early childhood growth, encompassing a series of qualitative changes in the ability to think, reason, remember, and solve problems. Piaget (2013) defines cognition as any form of mental activity that involves the acquisition and adaptive use of knowledge. Within the framework of Piaget's theory, children aged 2–7 years are in a preoperational stage characterized by the development of symbolic thinking skills, increasingly complex language use, and the emergence of *centration* and egocentrism. At this stage, children can represent objects through words and pictures, but their thinking remains intuitive rather than completely logical, so they need concrete experiences to build understanding (Santrock, 2011).

Vygotsky offers a complementary perspective through sociocultural theory that emphasizes the role of social interaction and cultural mediation in cognitive development. The concept *of Zone of Proximal Development* (ZPD) explains that there is a distance between what a child can do independently and what can be achieved with the help of a more competent adult or peer. Through *scaffolding*—the provision of gradual support that is reduced as the child's competence increases—children can achieve a higher level of development than they would on their own (Bodrova & Leong, 2007). The pedagogical implications of Vygotsky's theory are the importance of designing learning activities that allow for productive social interactions, including collaborative play that involves negotiation, discussion, and joint problem-solving.

Bruner (1966) complemented this theoretical framework with cognitive representation theory, which identified three stages of development: enactive (learning through direct action), iconic (learning through images and visual representations), and symbolic (learning through abstract symbols such as language and numbers). This progression from the enactive to the symbolic stage has important implications for the design of early childhood learning, in which activities must begin with the manipulation of concrete objects before moving on to visual representations and, finally, abstract symbols. This approach aligns with *the Concrete-Representational-Abstract* (CRA) principle recommended by the National Council of Teachers of Mathematics (NCTM, 2000) for effective mathematics learning.

Media Loose Parts in Early Childhood Learning

The concept *of loose parts* has its roots in *The Theory of Loose Parts,* formulated by architect Simon Nicholson (1971), which states that "in any environment, both the level of inventiveness and creativity, as well as the possibility of invention, is directly proportional to the number and type of variables present in it." This principle emphasizes that the more materials a child can manipulate, move, and combine in an environment, the greater the child's chances of developing creativity and thinking skills. Media *loose parts* include a wide range of materials—both natural (stones, twigs, grains, shells, sand) and artificial (bottle caps, pieces of wood, cardboard, patchwork, paper rolls)—that are *open-ended* and have no fixed use function.

In the context of early childhood education, *loose parts* have several pedagogical characteristics that make them a potential learning medium. First, its *open-ended* nature provides children with freedom to explore and create without limitations on the end result, supporting the development of divergent thinking and creativity (Flannigan & Dietze, 2017). Second, *loose parts* materials are concrete and can be manipulated directly according to the preoperative child's cognitive development stage, which requires *hands-on* experience (Piaget, 2013). Third, playing with *loose parts* naturally encourages social interaction and collaboration among children, which aligns with Vygotsky's theory of ZPD. Fourth, the availability and affordability of *loose parts* materials make them a practical solution for PAUD institutions with limited resources. Miller and Almon (2009) emphasized that *open-ended* materials are more effective at stimulating children's development than commercial toys with a single function.

Empirical studies on the effectiveness of *loose parts* in early childhood education show positive results. Maxwell *et al.* (2008) found that play environments enriched with *loose parts* increased the intensity and complexity of preschoolers' play. Gibson *et al.* (2017) in *the*

International Journal of Early Childhood reported that the availability of diverse manipulative materials in outdoor play environments is positively correlated with children's levels of exploration and creativity. In the Indonesian context, Astuti (2021) reported an improvement in children's early numeracy skills through *loose parts* media in a study published in *the Journal of Obsesi* (indexed SINTA 2). Meanwhile, Pratiwi and Lestari (2022) found a positive effect of playing with *loose parts* on creativity and early childhood cognitive development.

Initial Computational Ability and Its Urgency

Early numeracy skills are a critical component of early childhood cognitive development and a strong predictor of future academic success. Based on STPPA in Permendikbud Number 137 of 2014, the cognitive aspects of children aged 5–6 years include three scopes of development: (1) learning and problem solving, (2) logical thinking, and (3) symbolic thinking. Initial arithmetic skills fall within the third slice of the scope, involving understanding the concepts of numbers, one-to-one correspondence, cardinality, ordinality, and simple arithmetic operations.

Longitudinal research by Jordan *et al.* (2009), published in *Developmental Psychology* (indexed by Scopus), showed that numeracy competence at kindergarten age consistently predicted children's math achievement through the third grade of elementary school, even after controlling for general intelligence and socioeconomic status. Duncan *et al.* (2007), in a meta-analysis of six large-scale longitudinal studies, found that early math skills were the strongest predictors of a child's academic achievement later in life, surpassing reading and attention skills. These findings underscore the urgency of stimulating numeracy skills from an early age through an approach that is appropriate to the child's developmental stage.

METHOD RESEARCHS

This study uses the *Classroom Action Research* (CAR) method with a spiral model developed by Kemmis and McTaggart (1988). This model was chosen because it enables researchers to make gradual, continuous improvements in learning through reflective action cycles. Each cycle consists of four interrelated stages, namely: (1) planning, (2) *acting*, (3) *observing*, and (4) *reflecting*. The research was carried out in two cycles, each consisting of two meetings. Cycle I will be held in August 2025 and Cycle II in September 2025.

The subject of the study was the children of Group B of Kober Cempaka Putih, which amounted to 20 children, consisting of 12 girls and 8 boys, with an age range of 5–6 years. Kober Cempaka Putih is located in the Pamarican District, Ciamis Regency, West Java Province. This institution was chosen as the research site based on initial observations indicating low children's numeracy and limited variety in the learning media used by teachers. The research variables include input variables, namely children of Group B Kober Cempaka Putih, process variables, namely the application *of loose parts media* (bottle caps, small stones, used cardboard, and small wood) in counting activities, and output variables, namely the improvement of children's cognitive abilities in the initial counting aspect.

The data collection technique in this study uses three main instruments. *First*, structured observations carried out during the learning process using children's numeracy ability assessment sheets with four categories of developmental achievement based on Permendikbud Number 137 of 2014, namely: Not Yet Developed (BB/score 1), Starting to Develop (MB/score 2), Developing According to Expectations (BSH/score 3), and Developing Very Good (BSB/score 4). Observed indicators include: (a) the ability to count concrete objects 1–10 sequentially, (b) the ability to match the number of objects with the number symbols, (c) the ability to distinguish more or fewer quantities, and (d) the ability to construct simple patterns of objects. *Second*, documentation in the form of photos and videos of learning activities is used as supporting data to describe children's interactions with *loose parts media*. *Third*, field *notes* that describe children's behavior, responses to activities, and obstacles encountered during the implementation of actions.

Data analysis was carried out using qualitative and quantitative descriptive techniques. Qualitative analysis is carried out by organizing field-record data and documentation, then reducing the data, presenting it as a descriptive narrative, and drawing conclusions (Miles & Huberman, 1994). Quantitative analysis uses descriptive statistics in the form of calculating the percentage of child developmental achievement in each category (BB, MB, BSH, BSB) with the formula:

$$P = (f/N) \times 100\%$$

where P is the percentage, f is the frequency of children in a given category, and N is the sum of all children. The indicator of the action's success is determined by whether at least 75% of the children reach the Developing As Expected (BSH) or Developing Very Good (BSB) category.

The research procedure in each cycle includes four stages. In the *planning stage*, the researcher prepared a Daily Learning Implementation Plan (RPPH) with the theme of counting using *loose parts media*, prepared materials such as bottle caps, small stones, used cardboard, and small pieces of wood, and compiled observation instruments and assessment guidelines. At *the stage of implementing actions*, teachers carry out learning according to the RPPH that has been designed. The initial activity was filled with greetings, joint prayers, and an introduction to the media to be used. The core activity includes counting activities using *loose parts*, such as counting bottle caps, making patterns with small stones, matching objects to numbers, and arranging shapes made from cardboard and wood. The final activity was a reflection through questions and answers, followed by prayers and closing greetings. At *the observation stage*, the researcher, together with the classroom teacher and observer, made observations using a structured observation sheet. Finally, at the *reflection* stage, the observation data is analyzed to identify the successes and shortcomings of the action, which is then used as a basis for improvement in the next cycle.

RESULTS AND DISCUSSION

Results

Initial Condition (Pre-Cycle)

Before implementing the action, the researcher conducted initial observations to assess the condition of children's numeracy skills in Kober Cempaka Putih. Observations were made on 20 Group B children during regular learning activities. The results of pre-cycle observations indicate that children's overall numeracy ability remains relatively low to moderate. Of the 20 children observed, as many as 7 children (35%) were in the Starting Developing (MB) category, 9 children (45%) were in the Developing According to Expectations (BSH) category, and only 4 children (20%) reached the Very Good Development (BSB) category. No children are in the Undeveloped (BB) category. This data shows that most children still have difficulty in counting aspects such as counting objects in order, matching the number of objects with the number symbol, and distinguishing quantities. Children also showed low motivation and enthusiasm when counting activities were conducted using conventional methods with worksheets.

Results of Cycle I

Cycle I will be carried out in 2 meetings in August 2025, with the application of loose parts media in the form of bottle caps, small stones, used cardboard, and small wood. At the first meeting, the children were invited to count the caps of bottles and small stones according to the number mentioned by the teacher, as well as match the number cards with the number cards. In the second meeting, the activity focused on compiling patterns from used cardboard boxes and small pieces of wood, followed by counting the number of works of each child. During the implementation of the action, researchers and classroom teachers made observations simultaneously using structured assessment sheets. The results of Cycle I observations showed an increase compared to the pre-cycle condition. A total of 5 children (25%) are still in the Starting Growth (MB) category, 10 children (50%) are in the Developing As Expected (BSH) category, and 5 children (25%) have reached the Very Good Growth (BSB) category. This data shows a decrease in the number of children in the MB category (from 35% to 25%) and an increase in the BSB category (from 20% to 25%).

Reflection Cycle I identified several important findings. On the one hand, children showed a positive response to using *loose parts* as a counting medium—they appeared more enthusiastic and active than when using the worksheet. However, 5 children still have not shown optimal improvement. The causative factors include: (a) some children still need more intensive individual guidance, (b) activities tend to be individual so that interaction between children is not optimal, and (c) the variety of activities still needs to be enriched to maintain children's motivation. Based on these reflections, the researcher designed improvements for Cycle II.

Results of Cycle II

Cycle II was carried out in 2 meetings in September 2025, with modification of the action design based on the results of Cycle I's reflections. Three main improvement strategies were implemented: (1) the addition of group play activities to increase interaction and collaboration between children; (2) contextualization of counting activities through story narratives, for example, "building a house with a certain number of bricks" to give meaning to counting activities; and (3) the provision of *simple rewards* in the form of star stickers for children who actively participate to strengthen learning motivation. At the first meeting, children were invited to play in groups, counting and grouping bottle caps and small stones based on certain colors and quantities. In the second meeting, the children made construction shapes from used cardboard and small wood in groups, then counted the results. Activities are carried out alternately between individuals and small groups, with teachers giving children the opportunity to discuss among themselves.

The results of Cycle II's observation showed a very significant increase. There are no more children in the Starting Develop (MB) category, as many as 5 children (25%) in the Developing As Expected (BSH) category, and 15 children (75%) reaching the Very Good Developed (BSB) category. This data shows that the indicator of the success of the action has been achieved, namely, 100% of children are in the BSH or BSB category. A comparison of results between cycles is presented in Table 1.

Table 1. Recapitulation of Children's Cognitive Development Results Per Cycle

Category Perkembangan	Pre-Cycle	Cycle I	Cycle II
Not Yet Developed (BB)	0 (0%)	0 (0%)	0 (0%)
Start Growing (MB)	7 (35%)	5 (25%)	0 (0%)
Growing Up With Expectations (BSH)	9 (45%)	10 (50%)	5 (25%)

Category Perkembangan	Pre-Cycle	Cycle I	Cycle II
Very Well Developed (BSB)	4 (20%)	5 (25%)	15 (75%)
Quantity	**20 (100%)**	**20 (100%)**	**20 (100%)**
BSH + BSB	**13 (65%)**	**15 (75%)**	**20 (100%)**

Source: Data from research observations, 2025

Based on Table 1, a consistent upward trend is evident from pre-cycle to Cycle II. The percentage of children who reached the BSH and BSB categories increased from 65% (pre-cycle) to 75% (Cycle I) and reached 100% (Cycle II). On the other hand, the number of children in the MB category decreased gradually from 35% to 25% and finally 0%. This data indicates that the application of loose *parts media* with gradual improvement in each cycle has optimally improved the calculation abilities of all children.

Table 2. Average Achievement Score Per Numeracy Indicator

Indicator	Pre-Cycle	Cycle I	Cycle II
Counting objects 1–10 in order	2,45	2,90	3,70
Match the number of objects and numbers	2,30	2,75	3,55
Differentiating more/less	2,50	2,85	3,65
Compile a simple pattern	2,35	2,80	3,60
Overall average	**2,40**	**2,83**	**3,63**

Source: Observation data processing results, 2025

Table 2 shows the average increase in scores on each numeracy ability indicator from pre-cycle to Cycle II. The overall average increased from 2.40 (pre-cycle) to 2.83 (Cycle I) and 3.63 (Cycle II), indicating a 51.25% increase from the initial condition. The indicator "counting objects 1–10 sequentially" showed the highest increase, from 2.45 to 3.70, illustrating that direct manipulative activity with *loose parts* is very effective in stimulating children's sequential counting skills.

Discussion

The results of this study show that the application of *loose parts playing media* has significantly improved children's cognitive development, especially numeracy skills, in Kober Cempaka Putih through two action cycles. These findings can be analyzed from several theoretical perspectives and are supported by empirical evidence from previous research.

First, the improvement in children's numeracy skills following the use of *loose parts* aligns with Piaget's theory of cognitive development, which posits that children in the preoperational stage (ages 2–7 years) learn most effectively through direct interaction with concrete objects (Piaget, 2013). Media *loose parts,* such as bottle caps, small stones, scrap cardboard, and small wood, provide a *hands-on* experience that allows children to see, touch, count, and manipulate objects directly. This concrete experience facilitates assimilation and accommodation within the child's cognitive structure, making abstract concepts of numbers easier to understand. These findings are consistent with the research of Sarama and Clements (2009) published in *Early Childhood Research Quarterly* that the use of concrete manipulatives in early childhood mathematics learning significantly improves children's conceptual understanding of numbers and simple arithmetic operations.

Second, the more significant increase in Cycle II than in Cycle I can be explained through Vygotsky's *Zone of Proximal Development* (ZPD) theory. The addition of group play activities in Cycle II creates conditions where more competent children can help their peers who are still struggling (*peer scaffolding*). Vygotsky (in Santrock, 2011) asserts that social interaction with more capable peers is the main catalyst for a child's cognitive development. Research by Pyle and Danniels (2017), published in *Early Years: An International Research Journal* (indexed by Scopus), corroborates the finding that play-based learning involving collaboration between children results in higher cognitive achievement than individual learning. In addition, the contextualization of counting activities through story narratives in Cycle II aligns with the principle of *meaningful learning* from Ausubel (1968), which states that learning becomes more effective when new material is connected to the experience and knowledge children already have.

Third, the effectiveness *of loose parts* as a learning medium can also be understood through Bruner's (1966) representation theory. The activity of counting bottle caps and small stones represents the enactive stage, in which the child learns through direct actions. When children are asked to compose patterns and match objects to number cards, they enter an iconic stage that involves visual representation. In the end, the child's ability to accurately name the results of the count indicates the achievement of the symbolic stage. This gradual progression is consistent with *the Concrete-Representational-Abstract* (CRA) principle recommended by the National Council of Teachers of Mathematics (NCTM, 2000) as the optimal approach to children's mathematics learning. The study by Carbonneau *et al.* (2013), a meta-analysis published in *the Educational Psychology Review* (indexed by Scopus), confirmed that the use of manipulatives in mathematics learning has a moderate positive effect on students' understanding and achievement.

Fourth, giving simple *rewards,* such as star stickers, in Cycle II has proven effective in increasing children's motivation and active participation. This finding is consistent with *Skinner's reinforcement theory,* which posits that positive reinforcement increases the frequency of expected behavior (Santrock, 2011). In the context of this study, star stickers function as extrinsic reinforcement that encourages children to be more active and enthusiastic in participating in counting activities. Research by Corpuz (2021) in the *International Journal of Early Childhood Special Education* shows that the combination of manipulative media and positive reinforcement significantly increases engagement and learning outcomes in early childhood.

Fifth, *the open-ended* characteristics of loose *parts* media make an important contribution to children's creativity and divergent thinking. Nicholson (1971) asserts that the more variables that can be manipulated in a play environment, the higher the level of creativity that emerges. In this study, children not only learned to count but also experimented with different ways to arrange, group, and combine *loose parts*. These findings are supported by a study by Flannigan and Dietze (2017), which showed that the use *of loose parts* in children's play environments significantly improves preschoolers' constructive creativity and problem-solving abilities. Casey *et al.* (2008) in *Developmental Psychology* (indexed by Scopus) also found that integrating manipulative construction activities with story narrative improves the spatial abilities and mathematical comprehension of preschoolers.

Sixth, from a pedagogical perspective, the success of the application of *loose parts* in this study strengthens the relevance of *the play-based learning approach* in the PAUD curriculum. These results are consistent with a systematic literature review by Pyle *et al.* (2018) in the *Review of Education,* which concluded that play-based learning yields better cognitive and social-emotional outcomes than formal didactic approaches in early childhood. Miller and Almon (2009), in their report for the Alliance for Childhood, emphasized that the elimination of play from the kindergarten curriculum is a crisis that threatens the optimal development of children. The findings of this study are also consistent with the Developmentally Appropriate Practice (DAP) guidelines of the NAEYC, which recommend the use of diverse manipulative materials in early childhood learning (Bredekamp & Copple, 2009).

Overall, the improvement in numeracy ability from pre-cycle (average score of 2.40) to Cycle II (average score of 3.63) was 51.25%. The achievement of 100% of children in the BSH and BSB categories at the end of Cycle II exceeded the set success indicators (75%). These findings provide strong empirical evidence that loose *parts* media is an effective, contextual, and affordable learning solution to improve early childhood numeracy skills, especially in resource-constrained early childhood education institutions. This success also confirms the importance of learning design that is responsive to children's needs, based on continuous reflection, and integrates the principles of play, exploration, and collaboration.

Theoretical and Practical Implications

Theoretically, this study strengthens the argument that integrating Piaget's theory of cognitive development, Vygotsky's sociocultural theory, and Bruner's theory of representation can provide a comprehensive conceptual foundation for designing early childhood mathematics learning. Media *loose parts* have been shown to accommodate all three theoretical perspectives simultaneously—providing concrete experiences (Piaget), facilitating social interaction and *scaffolding* (Vygotsky), and supporting a gradual progression from enactive to symbolic representations (Bruner). These findings also contribute to the literature on *play-based learning* by providing empirical evidence from the context of non-formal early childhood education institutions in rural Indonesia, which have been underrepresented in international scientific studies.

Practically, this study shows that improving the quality of early childhood learning does not necessarily require high costs or advanced technology. The *loose parts* used in the study—bottle caps, small stones, scrap cardboard, and small wood—are all sourced from the surrounding environment and are recyclable materials that are easy to obtain at no cost. This makes *loose parts* a sustainable solution and can be replicated by PAUD institutions with various resource conditions. In addition, the findings that the combination of group play strategies, story contextualization, and simple *reward*-giving resulted in a greater improvement in Cycle II provide practical guidance for PAUD teachers in designing optimal loose parts-based learning activities.

Although the results of this study show positive findings, some limitations need to be noted. First, the classroom action research design did not use control groups, so the improvement in children's numeracy ability could not be attributed exclusively to loose parts media without considering other factors, such as children's developmental maturity and learning experiences outside of school. Second, the relatively small number of research subjects (20 children) and the limited location make the generalization of findings need to be done carefully. Third, the relatively short duration of the study (two cycles over two months) could not capture the long-term impact of using *loose parts* on children's cognitive development. Fourth, the observation instruments used are categorical checklists, so they cannot capture the child's thinking process while interacting with *loose parts in depth*. These limitations open up opportunities for further research with a more rigorous design and a wider scope.

CONCLUSION

Based on the results of the class action research conducted over two cycles in Kober Cempaka Putih, Pamarican District, Ciamis Regency, several conclusions can be drawn. First, the child's numeracy ability before the action showed suboptimal results, with 35% of children still in the Starting Developing (MB) category and only 20% achieving Very Good Development (BSB). Second, the application of *loose parts* media, such as bottle caps, small stones, used cardboard, and small wood, through gradually designed counting activities progressively improves children's numeracy skills. In Cycle I, the MB category decreased to 25%, and BSB increased to 25%. In Cycle II, with the addition of group-play strategies, story contextualization, and rewards, the increase became more significant—there were no children in the MB category, with 75% achieving BSB and 25% achieving BSH. Third, the average score for children's numeracy ability increased by 51.25%, from 2.40 in pre-cycle to 3.63 in Cycle II, exceeding the established success indicators. These findings confirm that *loose parts* media is effective not only in improving numeracy skills but also in fostering motivation, creativity, and enthusiasm for early childhood learning.

Based on the study's findings, several recommendations were formulated for various stakeholders. For early childhood teachers, it is recommended to integrate loose *parts* media consistently in daily learning planning, combining it with group play strategies and contextualization through stories to optimize learning outcomes. Teachers are also recommended to use materials from the surrounding environment as *loose parts,* so they do not require high cost, and to teach children the value of environmental sustainability.

For PAUD institution managers, it is recommended to provide adequate *loose parts* play *areas* and support teacher training on the use of *open-ended* media in learning. For future researchers, it is recommended to develop research with a wider scope, for example, using experimental designs with control groups to test the effectiveness of *loose parts* more rigorously, examining the influence *of loose parts* on other aspects of development, such as creativity and problem-solving skills, and exploring its implementation in the context of the Independent Learning curriculum at the PAUD level.

REFERENCES

Astuti, Y. (2021). Improving early childhood numeracy skills through loose-part media. Journal of Obsession: Journal of Early Childhood Education, 5(2), 876–885. https://doi.org/10.31004/obsesi.v5i2.642

Ausubel, D. P. (1968). Educational psychology: A cognitive view. Holt, Rinehart and Winston.

Bodrova, E., & Leong, D. J. (2007). Tools of the mind: The Vygotskian approach to early childhood education (2nd ed.). Pearson.

Bredekamp, S., & Copple, C. (2009). Developmentally appropriate practice in early childhood programs (3rd ed.). National Association for the Education of Young Children.

Bruner, J. S. (1966). Toward a theory of instruction. Harvard University Press.

Carbonneau, K. J., Marley, S. C., & Selig, J. P. (2013). A meta-analysis of the efficacy of teaching mathematics with concrete manipulatives. Journal of Educational Psychology, 105(2), 380–400. https://doi.org/10.1037/a0031084

Casey, B. M., Andrews, N., Schindler, H., Kersh, J. E., Samper, A., & Copley, J. (2008). The development of spatial skills through interventions involving block building activities. Cognition and Instruction, 26(3), 269–309. https://doi.org/10.1080/07370000802177177

Clements, D. H., & Sarama, J. (2011). Early childhood mathematics intervention. Science, 333(6045), 968–970. https://doi.org/10.1126/science.1204537

Corpuz, J. C. G. (2021). Integrating manipulative materials and positive reinforcement in early childhood mathematics: A mixed-methods inquiry. International Journal of Early Childhood Special Education, 13(2), 912–921. https://doi.org/10.9756/INT-JECSE/V13I2.211151

Ministry of National Education. (2003). Law of the Republic of Indonesia Number 20 of 2003 concerning the National Education System. Department of National Education.

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., Pagani, L. S., Feinstein, L., Engel, M., Brooks-Gunn, J., Sexton, H., Duckworth, K., & Japel, C. (2007). School readiness and later achievement. Developmental Psychology, 43(6), 1428–1446. https://doi.org/10.1037/0012-1649.43.6.1428

Flannigan, C., & Dietze, B. (2017). Children, outdoor play, and loose parts. Journal of Childhood Studies, 42(4), 53–60. https://doi.org/10.18357/jcs.v42i4.18103

Gibson, J. L., Cornell, M., & Gill, T. (2017). A systematic review of research into the impact of loose parts play on children's cognitive, social and emotional development. School Mental Health, 9(4), 295–309. https://doi.org/10.1007/s12310-017-9220-9

Jordan, N. C., Kaplan, D., Ramineni, C., & Locuniak, M. N. (2009). Early math matters: Kindergarten number competence and later mathematics outcomes. Developmental Psychology, 45(3), 850–867. https://doi.org/10.1037/a0014939

Ministry of Education and Culture. (2014). Regulation of the Minister of Education and Culture Number 137 of 2014 concerning National Standards for Early Childhood Education. Ministry of Education and Culture.

Kemmis, S., & McTaggart, R. (1988). The action research planner (3rd ed.). Deakin University Press.

Maxwell, L. E., Mitchell, M. R., & Evans, G. W. (2008). Effects of play equipment and loose parts on preschool children's outdoor play behavior: An observational study and design intervention. Children, Youth and Environments, 18(2), 36–63.

Miles, M. B., & Huberman, A. M. (1994). Qualitative data analysis: An expanded sourcebook (2nd ed.). Sage Publications.

Miller, E., & Almon, J. (2009). Crisis in the kindergarten: Why children need to play in school. Alliance for Childhood.

Montessori, M. (2007). The discovery of the child. Ballantine Books.

National Council of Teachers of Mathematics. (2000). Principles and standards for school mathematics. NCTM.

Nicholson, S. (1971). How not to cheat children: The theory of loose parts. Landscape Architecture, 62(1), 30–34.

Piaget, J. (2013). Child psychology (Terj. Miftahul Jannah). Student Library.

Pratiwi, S., & Lestari, A. (2022). The effect of the loose part play method on early childhood creativity and cognition. Early Horizons: Journal of Early Childhood Education, 13(1), 33–42. https://doi.org/10.17509/cd.v13i1.38244

Pyle, A., & Danniels, E. (2017). A continuum of play-based learning: The role of the teacher in play-based pedagogy and the fear of hijacking play. Early Education and Development, 28(3), 274–289. https://doi.org/10.1080/10409289.2016.1220771

Pyle, A., DeLuca, C., & Danniels, E. (2018). A scoping review of research on play-based pedagogies in kindergarten education. Review of Education, 6(3), 311–351. https://doi.org/10.1002/rev3.3122

Santrock, J. W. (2011). Life-span development (13th ed.). McGraw-Hill.

Sarama, J., & Clements, D. H. (2009). Early childhood mathematics education research: Learning trajectories for young children. Routledge.

Sujiono, Y. N. (2013). The basic concept of early childhood education. Index.

Suyadi. (2014). Early childhood learning theory in neuroscience studies. PT Remaja Rosdakarya.

Yuliani, S. (2019). Integrated learning approach in PAUD. Alphabet.