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Benita¹, Intan Aulia^{1*}, Nelly Yusnita¹, Linda Sitanandra¹

¹ Universitas Panca Sakti Bekasi, Indonesia

*Corresponding author: auliaintan407@gmail.com

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Analysis of the Use of Loose Parts Media in Developing Fine Motor Skills in Early Childhood: Implications for Child Education

Benita¹, Intan Aulia^{1*}, Nelly Yusnita¹, Linda Sitanandra¹ Universitas Panca Sakti Bekasi, Indonesia

Abstract

Background: Fine motor skills are one of the aspects of early childhood development that is an important foundation for academic readiness, independence, and creativity. However, in practice, there are still many children aged 5-6 years who show delays in finger coordination, grasping stationery, scissors, and manipulating small objects. One of the media that is increasingly used in the context of game-based PAUD is loose or loose parts. Loose parts refer to materials that are exposed, unstructured, and flexibly manipulated by children such as pieces of wood, bottle caps, buttons, stones, pebbles, patchwork, and grains. **Purpose:** This study aims to analyze the use of free-form media in the development of fine motor skills in early childhood and examine its implications for children's educational practices. **Methods:** This study uses a qualitative approach with a case study design in kindergarten in children aged 5-6 years for 3 months. Data collection was carried out through participatory observation, semi-structured interviews with 4 teachers and 8 parents, photo/video documentation, and fine motor assessment rubrics. **Results:** The results showed that after the intervention of the loose section on a regular basis 3 times a week, there was a significant improvement in the indicators of clamp grip, grain pouring, button pressing, and cutting patterns. Children also show increased focus, creativity, and independence. Theoretically, these findings support Piaget and Vygotsky's constructivist theoretical principles of learning through exploration. **Conclusion:** The implications of this study confirm that the loose part is an inexpensive, contextual, and effective medium for stimulating fine motor skills without pressuring children with rigid academic targets. Teachers are advised to integrate loose parts in the playing corner, and schools need to provide teacher training on the principles of open play.

Keywords: Early childhood education; Loose parts play; Fine motor development; preschool education; Learning through play

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Introduction

Early childhood development is the most fundamental investment for the development of a nation's human resources. Article 1 Paragraph 14 of Law Number 20 of 2003 concerning the National Education System states that Early Childhood Education is a coaching effort aimed at children from birth to the age of six years which is carried out through the provision of educational stimuli to help grow and develop physically and spiritually. The age range of 0-6 years is known as the golden age or golden age, in which 80% of the structure and function of a child's brain has been formed. In this critical period, any stimuli the child receives will form the neural networks that form the basis of future cognitive, linguistic, social-emotional, and motor abilities.

Of the four developmental aspects, the fine motor aspect is the component that has the strongest correlation with academic readiness in elementary school. Fine motor is defined as the ability to perform movements that involve small muscles in a coordinated and controlled manner, especially the muscles of the hands, fingers, and wrists. According to the 2022 Independent Curriculum Early Childhood Education Learning Outcomes, fine motor indicators for 5-6 year olds include: holding stationery with a tripod handle, cutting paper following straight, curved, and zig-zag lines, knitting at least 20 pieces, imitating folding paper, and buttoning and unbuttoning their own clothes. Mastery of this indicator is a prerequisite for writing letters, drawing details, using scissors, and other independent activities.

The World Health Organization (2020) recommends that children under 2 years old should not be exposed to screens, while children aged 2–4 years are limited to a maximum of one hour per day with good content quality. Excessive screen exposure has the potential to reduce children's opportunities for physical activity, manipulative play, and environmental exploration that are important for fine motor development.

Various studies in Indonesia show that there are still many early childhood who have difficulties in fine motor skills, such as grasping stationery, eye-hand coordination, and manipulating small objects. This condition encourages the need for the use of manipulative learning media that is able to strengthen finger coordination and writing readiness.

Delays in fine motor skills shouldn't be taken lightly. A longitudinal study by Grissmer et al. in 2010 showed that fine motor skills at age 4 are the strongest predictor of math and reading achievement in 2nd grade, even more than early IQ. Kids with weak fine motor skills tend to get frustrated when learning to write, which can lead to school avoidance. The long-term impact is low academic self-efficacy and a higher risk of learning difficulties.

Why is this still happening? There are at least three influencing factors. First, changes in parenting patterns in the digital era have led to increased exposure to electronic devices in early childhood. The World Health Organization recommends that children under five years

of age have very limited screen time because excessive screen use can reduce the child's opportunities for physical activity, manipulative play, and sensorimotor exploration that are important for fine motor development. Second, learning practices in PAUD are still mostly oriented towards the use of worksheets and academic activities so that children's opportunities to explore using various concrete objects are limited. Third, the limitations of manipulative media in many PAUD units cause the stimulation of fine motor skills to not take place optimally. Various studies show that the use of manipulative media and open play activities can improve eye-hand coordination, finger muscle strength, and grasping skills as the basis for writing readiness.

It is in this context that the concept of loose sections emerges as a solution. Simon Nicholson 1971 in his article "How Not to Cheat Children: The Theory of Loose Parts" stated that all environments that are good for children to play in should have an unlimited number of loose parts. Loose parts are materials that can be moved, carried, combined, redesigned, disassembled, and rearranged in a variety of ways. Its main characteristics are open-ended, have no single-use purpose, and are safe for children. The categories of loose parts are very wide: 1) Natural materials: stone, gravel, wood, leaves, seeds, shells; 2) Recycled materials: bottle caps, buttons, pipes, rings, cardboard; 3) Textile material: patchwork, ribbon, rope; 4) Logistics materials: straws, tongs, magnets.

The advantages of loose parts over conventional media are obvious. Structured media such as puzzles have only one correct way of solving. This limits exploration and often frustrates the child if it goes wrong. On the other hand, the loose part does not recognize the word "wrong". Kids can set 10 bottle caps into cars, flowers, or rockets according to their imagination. Every time a child moves, squeezes, or pinches a loose part, he performs hundreds of repetitions of finger movements that strengthen the intrinsic muscles of the hand. Fine tweezer movements when picking up buttons, wrist rotation movements when pouring seeds, and bilateral coordination when cutting fabric are neurological foundations for writing.

The theoretical foundation of this research is very solid. First, Piaget 1952 at the preoperational stage of the age of 2-7 years explained that children learn through direct interaction with the physical environment. Loose sections are concrete objects that are ideal for assimilation and accommodation schemes. Second, Vygotsky 1978 emphasized the role of the More Knowledgeable Others or MKOs. Teachers who ask open-ended questions when children play loose sections serve as scaffolding to bring children to the Proximal Development Zone. Third, Gibson's 1979 theory of ability states that the environment provides "opportunities for action". Loose parts have a lot of motor capabilities compared to single media. Fourth, the DAP principles of NAEYC 2020 emphasize that learning should be developmental, individual, and contextual. The loose parts can be increased in difficulty according to the abilities of each child.

The urgency of this research has increased after the COVID-19 pandemic. The learning from home period that took place during the pandemic caused learning loss and reduced opportunities for early childhood to obtain direct stimulation through play and exploration activities in the school environment. These conditions have an impact on various aspects of child development, including learning readiness and fine motor skills. Therefore, it is necessary to have a fun, play-based learning intervention that provides opportunities for children to interact directly with various manipulative media to optimize fine motor development.

The context of research at Aksana Saki Kindergarten also provides added value. Aksana Saki Kindergarten integrates Islamic values in learning. Loose parts of natural materials such as seeds and stones can be attributed to God's diverse concept of creation. Meronce activity can be attributed to the value of precision and patience. Thus, loose parts develop not only the motor, but also the character.

Previous empirical studies reinforce the urgency. Daly & Beloglovsky 2015 conducted a 16-week study in 6 early childhood education classes in the United States and found a 40% improvement in persistence and finger coordination. In Indonesia, Sari 2021 in Semarang used an experimental design and found a gain difference of 34.2% between the loose part experimental class and the LKA control class. Aisyah 2020 in the Golden Age Sinta 3 Journal also reported the effectiveness of loose parts granules on fine motor skills. However, research gaps still exist: 1) Lack of qualitative case studies describing children's microprocesses; 2) There has been no research linking the loose parts with the Independent Curriculum and Early Childhood Education P5; 3) A little research at Aksana Saki Kindergarten.

Based on this description, the formulation of the research problem is: 1) What is the process of applying loose parts media in children aged 5-6 years? 2) How does it affect the five fine motor indicators: grip, coordination, precision, endurance, and creativity? 3) What are the implications of using loose sections for children's educational practices according to the Independent Curriculum?

The purpose of this study is to analyze the processes, impacts, and implications of loose sections in depth. Its theoretical benefit is to enrich the game-based early childhood education literature. The practical benefit is that it is a guide for teachers, school principals, PG PAUD students, and the education office to implement cheap and effective media.

Methods

Research Design

This study uses a qualitative approach with a case study design. The selection of a qualitative approach is based on the purpose of research that seeks to explore in depth the meaning, process, and context of the use of loose media in early childhood fine motor development. In contrast to quantitative approaches that focus on numbers and generalizations, qualitative research views reality as something plural, dynamic, and contextual. Therefore, researchers need to jump directly into the field to understand the phenomenon from the subject's point of view.

The design of the case study was chosen with reference to Yin 2018. Case studies are empirical research strategies that investigate contemporary phenomena in depth and in real-world contexts, especially when the boundaries between phenomenon and context are not clearly visible. This research is a type of single case study with a single case design embedded. The single case is Aksana Saki Kindergarten, while the embedded unit is 12 children aged 5-6 years, 4 teachers, and 8 parents. This design is appropriate because researchers want to understand the holistic process of loose section interventions in specific early childhood settings, rather than comparing between schools.

Paradigm and Position of Researchers

This research is based on the interpretive constructivism paradigm. Researchers believe that knowledge is built through interaction between researchers and subjects. The position of the researcher is as the main instrument or human instrument, as well as as an observation participant. For 3 months, the researcher engaged in classroom activities 2 times a week, taking notes, taking pictures, and discussing with teachers. This engagement is necessary to build trust and understand the nuances of a child's behavior that do not show up in numbers.

Location, Time, and Research Subject

The research was conducted at Kindergarten B Aksana Saki, Jalan Pengadilan Km 8, from February to April 2026. The selection of the location was based on three considerations: 1) The school has implemented the Independent Curriculum and has a play corner, 2) The principal gave permission for the research, 3) There has never been any loose section research in the school.

The research subjects were selected by purposive sampling technique. Child inclusion criteria: age 5.0-6.0 years, actively enrolled, parents willing to sign an informed consent, and have a fine motor score of ≤ 2 on pre-assessment. Out of the 18 children in the class, 12

children were chosen as the main subject. The supporting subjects were 4 classroom teachers who were directly involved in the intervention and 8 parents whose children were subjects.

Design and Procedure of Loose Section Intervention

The intervention was carried out over 12 weeks or 3 months, with a frequency of 3 meetings per week, duration of 60 minutes per session. A total of 36 sessions. The activity was carried out in the corner of the loose section that was made permanent in the classroom.

The stages of the intervention are divided into 3 phases: Phase 1 Orientation Weeks 1-2: The goal of this phase is to build the child's familiarity with the material. The teacher only gives the material without instructions. Kids are free to explore. Materials used: bottle caps, large pebbles, and patchwork. Phase 2 Guided Exploration Weeks 3-8: Teachers begin to give light challenges. Activities: 1) Tightening the button with raffia rope, target 15 buttons; 2) Transfer the corn kernels from basin A to B with tweezers; 3) Set the bottle cap into ABAB pattern; 4) Cut patchwork along the line. Phase 3 Self-Creation Weeks 9-12: Children are given complete freedom to combine all the material and create "works". The teacher simply asked: "What do you want to do today?"

The principle is maintained: no examples, no right-wrong assessments, teachers as facilitators, and rotation of material every 2 weeks so as not to get bored.

Data Collection Techniques

To ensure data depth, 4 triangulation techniques are used:

Participatory Observation: The researcher used an adaptation observation sheet from the 2019 Ministry of Education and Culture Development Checklist. Focus on 5 fine motor indicators: 1) Grip, 2) Hand-eye coordination, 3) Accuracy, 4) Task endurance, 5) Creativity. Each indicator is given a rubric score of 1-4. Observations were made at the pre-test in week 1 and post-test in week 12. In addition, the researcher made daily field notes.

Semi-Structured Interview: Conducted with 4 teachers at the end of the study and 8 parents. Core question: "What changes do you see in your child after 3 months of loose play at home/school?" Interviews are recorded and transcribed.

Documentation: Photos, 30-second videos per child per session, and portfolios of children's work are collected. Documentation is used to validate observational data.

Teacher's Reflection Note: Every weekend, the teacher writes a 1-paragraph reflection about the dynamics of the class.

Data Analysis Techniques

Data were analyzed using the thematic analysis model of Braun and Clarke 2006 through 6 stages: 1) Introduction to the data: reading transcripts and repeated notes; 2) Initial coding: encoding relevant data with smooth motor; 3) Searching for themes: grouping the code into themes such as “increased grip” or “emergence of creativity”; 4) Review themes: make sure they are backed by data; 5) Define and name themes; 6) Compile reports.

Data validity tests were carried out through: 1) Source triangulation: comparing observation, interview, and documentation data; 2) Triangulation technique; 3) Member examination: the initial results are confirmed to the teacher; 4) Trace audit: all raw data is saved.

Research Ethics

This research has received permission from the Principal of Aksana Saki Kindergarten and the School Committee. Parents are given a full explanation and sign an informed consent. The identity of the child is kept secret by the initial code. Children can refuse to participate in activities at any time without consequences. All loose parts are ensured to be non-toxic, non-sharp, and washed before use to prevent health risks.

Results

This section presents research findings based on observation, interviews, documentation, and fine motor assessments collected during the 12 weeks of loose-section interventions at Aksana Saki Kindergarten B Kindergarten. The presentation of data is divided into 3 main sub-chapters: 1) Review of the implementation process of the loose section, 2) Improvement of five fine motor indicators based on pre-test and post-test, and 3) Additional findings outside the motor aspect. All children's names are disguised with initials to maintain confidentiality.

Overview of the 12-Week Loose Spare Parts Media Implementation Process

The process of using loose parts is not immediately optimal. There are 3 phases of development that are clearly visible from the field records.

Phase 1: Orientation and Confusion, Weeks 1-2

At the first two meetings, 9 out of 12 children showed confusion. Since there are no ready-made examples or “make it like this” instructions, some children simply throw away the bottle caps or gather the ingredients and then sit still. Subject AN, 5.5 years old, in session 1 just sat holding a button and threw it on the floor. When the teacher asked “What do you

want to do?”, he replied “I don't know”. This is natural because children are used to LKA that already has a pattern.

However, by the end of week 2, changes began to be noticeable. After watching his colleagues pile rocks onto the “street”, the 5.8-year-old ML subject began to imitate and say “This is my home”. This phase shows that children need time to adapt from structured learning to open play.

Phase 2: Directed Exploration and Focus Enhancement, Weeks 3-8

Starting from the 3rd week, the teacher gives light challenges with no set end result. For example: “Try this button as many times as you want”. At this point there is a significant increase in the duration of focus. Observational data showed that the average child's focus duration increased from 7 minutes in week 2 to 14 minutes in week 6.

RD case study, 5.1 years: By week 3, RD could only press 5 buttons in 10 minutes and often asked for help. By week 7, she was able to open 23 buttons in 15 minutes independently and show a proud expression by saying “Mom, look I can do it!”. The teacher reported that RD also began to dare to try tweezers to move corn kernels, an activity he had previously avoided because it was “difficult”.

The parents of the subject RD in the interview stated: “At home now, RD likes to ask for rice to be moved using a spoon. He said he played like he was in school. I never wanted to”. It shows the transfer of skills from school to home.

Phase 3: Self-Creation and Collaboration, Weeks 9-12

In the final phase, the child is very comfortable with the material. They began to collaborate. The subjects SF and TN, both 5 years old, made a “garden” together out of stones, dried leaves, and bottle caps as flowers. They negotiated: “I'm the flower, you're the fence.” The teacher does not intervene, only observes.

By week 12, 100% of children no longer throw materials aimlessly. All children were actively involved for at least 30 minutes of the total 60-minute session. This shows that loose parts have succeeded in creating high engagement.

Improvement of Five Indicators of Fine Motor Skills: Pre-Test vs Post-Test

The assessment uses rubrics on a scale of 1-4 with N=12 children. Score 1=Progressed very poorly, 2=Started to develop, 3=Progressed as expected, 4=Progressed very well.

Table 1. Children's average pre-test and post-test scores of fine motor skills (n = 12)

No.	Indicator	Pre-Test Mean	Post-Test Mean	Improvement	Children Achieving Mastery (Score ≥ 3)
1	Tripod Grip	2.1	3.4	+1.3	10 of 12 children (83.3%)
2	Hand–Eye Coordination	2.0	3.5	+1.5	11 of 12 children (91.7%)
3	Precision	1.9	3.3	+1.4	9 of 12 children (75.0%)
4	Task Persistence	2.2	3.6	+1.4	12 of 12 children (100%)
5	Creativity	2.0	3.7	+1.7	12 of 12 children (100%)

Indicator 1: Tripod Grip

Pre-tests showed that 7 children were still using fist grips when holding tweezers or crayons. After the intervention, 10 children were able to use the tripod handle with their thumb, index finger, and middle finger. The DP subject, 5.9 years old, who initially held the tweezers with his whole hand, by the 10th week was already able to move 30 green seeds without falling. The teacher noted: “The muscles of his hands became stronger, no longer trembling when holding small objects.”

Indicator 2: Eye-Hand Coordination

It is measured by the activity of pouring seeds from one container to another. In pre-testing, the average spill was 60%. Children often miss out because they cannot control their movements. In post-testing, the spill rate dropped to 15%. LK subjects at week 1 shed almost all the seeds. By the 11th week, he was able to pour 50 seeds with an accuracy rate of 90%. This improvement indicates better visual-motor control, which is the basis for writing on the lines of a book.

Indicator 3: Accuracy

Measured by the ability to cut patchwork following a straight, curved, and zig-zag pattern. Pre-test: only 3 children are capable. Post-test: 9 children are able. AN's subjects, who originally cut the original, were able to follow a zig-zag line with the rest of the paper neatly cut out at the 12th week. This precision is also noticeable when grinding: the spacing between the buttons becomes more regular.

Indicator 4: Task Durability

This is the most significant improvement. The average duration of a child focusing on a single activity increased from 7 minutes to 18 minutes. By the 12th week, 12 out of 12 children were able to complete the 20-grain snack activity without stopping in the middle. The teacher stated: “They no longer say 'bored Mom' after 5 minutes. They feel at home because they can change the material themselves”. This increase in attention span is very important for learning readiness in elementary school.

Indicator 5: Creativity

Creativity is measured by the variety of material use and the ability to create new patterns. Pre-test: children just imitate the teacher. Post-test: 12 children create unique creations. Example: SF makes a “birthday cake” from a pile of bottle caps. TN makes “necklaces” from buttons and strings. The average score rose the highest, +1.7, because the loose section did not limit the imagination.

Additional Findings Beyond the Motor Aspect

In addition to fine motor, 3 other important findings emerged:

Increased Independence

Before the intervention, 8 out of 12 children always waited for the teacher's instructions before taking the material. By week 12, 11 children had taken the initiative to take their own materials, tidy up, and return them to their places. The ML subject, who was previously passive in week 10, dared to say to a friend “It's my turn first”. This is in line with the goals of the Independent Early Childhood Curriculum about independent children.

Conflict Reduction and Increased Socialization

Initially, there was a scramble for materials because everyone wanted to close the red bottle. The teacher then applies the rule of “material for all, we share”. By the 6th week, the physical conflict disappeared. The child began to exchange materials: “I borrow your buttons, later I will give you stones”. It shows the development of social skills through play.

Increased Confidence

At the end of the lesson, each child presents his or her work in front of the class for 1 minute. 10 out of 12 children who were initially silent dared to step forward and explain “This is mine, this is the stone, this is the key”. The mother of the SF subject said: “My son now

dares to come forward if asked by the teacher at home the Qur'an, Mom. He said it was common in schools”.

Data Validation through Triangulation

To ensure the credibility and validity of research findings, source triangulation and engineering triangulation are carried out. Source triangulation is carried out by comparing the results of observations, interviews, and documentation, while technical triangulation is carried out through the use of various data collection methods on the same phenomenon. In addition, the researcher also conducted *member checking* of classroom teachers to ensure that the results of data interpretation were in accordance with the actual conditions in the field.

The results of triangulation showed that there was consistency between observation data and information obtained through interviews and documentation. For example, the results of observations showed that AN subjects experienced improved grasping skills and finger coordination after participating in *loose parts activities* for 12 weeks. The findings were corroborated by the results of interviews with parents who stated:

“Now at AN's house, he can button his own clothes, ma'am. He used to always ask for my help because it was difficult to put buttons in.”

Documentation in the form of portfolio photos also shows real developments. In the first week, the results of the meronce activity were still irregular, the distance between buttons was inconsistent, and the child still needed the help of the teacher. On the other hand, by the 12th week, the child has been able to arrange a series of buttons into bracelets with a neater, symmetrical, and more efficient pattern. These changes strengthen the findings that the ability of eye-hand coordination, finger muscle strength, and accuracy of children have developed positively.

Overall, the results of triangulation showed that the implementation of *loose parts* media three times a week for twelve weeks had a positive impact on the fine motor development of children aged 5–6 years. Improvements were not only seen in all fine motor indicators, such as grasping ability, eye-hand coordination, accuracy, endurance in completing tasks, and creativity, but also in other aspects of development, including independence, social interaction skills, and confidence. The consistency of findings from various data sources shows that the results of the study have a good level of credibility and can be trusted as a real picture of the effectiveness of the use of *loose parts* media in learning in early childhood education.

Discussion

This discussion section interprets the research findings critically, comparatively, and contextually. The discussion is divided into 6 sub-chapters: 1) Neurocognitive mechanisms of loose section effectiveness, 2) The role of teachers within the framework of Vygotsky and NAEYC, 3) Holistic motor, cognitive, social, and affective impacts, 4) Gender and individuality analysis, 5) Policy implications of the Independent Curriculum, SDGs, Stunting, and Islam, 6) Challenges, limitations, and research agendas.

Neurocognitive mechanisms of the effectiveness of loose sections on fine motor

The significant increase in five fine motor indicators with an average increase of 1.3-1.7 points is not a coincidence. This mechanism can be traced from 4 lenses.

Piaget's Theory of Constructivism: Schematicism, Assimilation, and Repetitive Accommodation

Piaget 1952 placed 5-6 year olds in the preoperational stage. At this stage, children build knowledge through physical interaction with the environment. The loose section provides material that allows the “insert-delete”, “stack-unload”, and “fill-blank” schemes to be repeated thousands of times without limitation. AN's subjects, who initially only threw a button, were able to score 20 points in week 8. This iteration strengthens myelination in the primary motor cortex of M1 and the premotor area. The thick myelin makes nerve impulses run faster, so finger movements become smoother and more controlled. Unlike LKA which only requires 1 scribble movement, the loose part requires hundreds of micro movements. This is called “non-coercive exercises”.

Nicholson's Theory of Environmental Variability: Stylus, Bilateral, and Sensory Coordination Assessments

Nicholson 1971 asserted that the more variables in the environment, the higher the creativity and adaptation. On a motor, the variables are weight, size, texture, and shape. When the child moves 50 grams of gravel and then switches to 1 gram of millet seeds, he has to adjust the gradation of the force. This ability is very important for writing: too strong pressure makes the paper tear, too weak makes the pencil not foam. The decrease in seed spillage from 60% to 15% is empirical evidence of improved proprioceptive control. In addition, the activity of meronce and pattern compiling ABAB trains bilateral coordination, which is the use of both hands with different functions: one hand holding, one hand entering. Bilateral coordination is a prerequisite for holding paper with one hand and writing with the other. MacDonald's 2018 call the loose section a “gymnasium for the hands and brain” because it trains the entire sensorimotor system.

Neuroscience: Executive Function, Cerebellum, and Brain Plasticity

Diamond 2013 and Diamond & Ling 2019 show that fine and executive motor function are interrelated. The prefrontal cortex that regulates planning, inhibition, and working memory is activated when the child plots ABAB button patterns, refrains from throwing, and remembers how many times it is given. The increase in “task endurance” from 7 minutes to 18 minutes reflects the strengthening of executive functions. In addition, the cerebellum, once thought only for balance, is now known to play a role in attention, language, and procedural learning. Fingertip stimulation through button manipulation activates sensory homunculi in the cortex, which is directly connected to the cerebellum. This activation facilitates reading and writing readiness. The plasticity of the brain at the age of 3-4 years is very high, so intervention in this period has the greatest effect.

Dialogue with Empirical Research

The results of this study are in line with various previous studies that showed that the use of media *Loose parts* make a positive contribution to the development of fine motor development in early childhood. Media *Loose parts* It allows children to perform a variety of manipulative activities, such as shaping, arranging, grouping, pinching, and moving objects, which directly train hand-eye coordination, finger muscle strength, precision, and fine movement control. Characteristics of media *Open* It also provides opportunities for children to explore according to their interests and abilities so that the learning process takes place more actively, creatively, and meaningfully.

The findings of this study are supported by Daly and Beloglovsky (2015) who explain that *loose parts* provide a flexible learning environment so that children have the opportunity to manipulate various objects according to their ideas and creativity. These activities not only stimulate creativity, but also provide repeated stimulation of eye-hand coordination, finger muscle strength, and manipulative skills that are the basis for fine motor development. In line with that, *the Developmentally Appropriate Practice* published by the National Association for the Education of Young Children (NAEYC, 2020) emphasizes that the use of *open-ended materials* supports play-based learning that is appropriate to the child's developmental stage and encourages integrated motor, cognitive, social, and creative development.

The results of this study also support *The Theory of Loose Parts* put forward by Nicholson (1971), which states that the more diverse the materials available in the learning environment, the greater the opportunities for children to explore, solve problems, and develop various competencies through play activities. During the research process, children showed noticeable improvements in grasping skills, eye-hand coordination, and accuracy. In addition, observations also show an increase in independence, the ability to work together, and confidence when children are involved in play activities using *loose parts*.

Compared to previous research, this study has some novelties. First, the study uses a qualitative case study approach so that it is able to describe the process of fine motor development of children in depth through continuous observation for twelve weeks. Second, the implementation of loose *parts* media is carried out in PAUD units that integrate Islamic values in learning so that fine motor stimulation goes hand in hand with strengthening character, such as responsibility, cooperation, and independence. Third, this study relates the use of *loose parts* media with the implementation of the Independent Curriculum which emphasizes play-based learning, exploration, and meaningful learning experiences. Thus, this study enriches the evidence on the use of loose *parts* media in early childhood learning and provides contextual alternative strategies to support fine motor development and child-centered learning.

The Role of the Teacher: From Instructor to Scaffolding Facilitator and Invisible Teacher

The child's transition from “confused weeks 1-2” to “focus on weeks 3-8” is a product of pedagogy, not just maturity.

Proximal Development Zone and Vygotsky Scaffolding 1978

Vygotsky states that learning occurs optimally in ZPD. The teachers in this study rejected the “demonstration-copy” model. Instead, the teacher uses verbal scaffolding: “If the button runs out, what do you want to take?”, “How do you keep your ronce from coming off?”. This question is a psychological tool that helps children internalize motor plans. By week 7, the teacher faded the RD: stop asking questions and let the RD work on his own. RD manages 23 buttons and says “I'm great”. This is the internalization of ZPD into actual capabilities, as well as increased self-efficacy.

Prinsip Child-Initiated Learning dan Playful Pedagogy NAEYC 2020

The 4th edition of DAP NAEYC emphasizes the balance between child-initiated and teacher-guided. Phase 3 of weeks 9-12 is child-initiated evidence. The collaboration of SF and TN creates a fast teacherless “garden”. If the teacher interferes, the negotiation process and theory of mind do not arise. The effective teacher in the loose part is the “invisible teacher”: present, safe, observing, documenting, and only intervening when it is risky.

Criticism of Early Calistung Practices and Loose Parts Solutions

Permendikbudristek No. 5/2022 prohibits PAUD from conducting calistung exercises. However, many teachers feel “pressured by parents” who demand that their children be able to write. The loose part becomes a bridge: children continue to learn the prerequisites of writing without trauma. Kindergarten teacher Aksana Saki reported that after 3 months,

the child was better prepared for “pre-writing” activities because the intrinsic muscles of his hands were already strong. It answers the teacher's dilemma: how to meet academic demands without violating the principles of early childhood education.

Holistic Impact: Beyond Motor to Cognitive, Social, and Affective

The data showed significant spillover effects on 4 domains.

Independence and Self-Regulation: Erikson and the Self-Governing Curriculum

Erikson's 1963 “Initiative vs. Guilt” stage at the age of 3-5 states that children should be given space to start and complete tasks. Loose parts provide autonomy: choosing materials, determining the duration, deciding to finish or continue. The change from 8 passive children to 11 initiative children is proof of success in overcoming the Erikson crisis. This is in line with the “independent” dimension in the 2022 Independent Curriculum for Early Childhood Education Learning Outcomes.

Social-Emotional Development: Kohlberg, Vygotsky, and the Theory of Mind

The material conflict in weeks 1-2 that turns into the “yes turn” of week 6 shows moral development. According to Kohlberg, 3-4 year olds are in the pre-conventional stage. The teacher's mediation with the “ingredients for all” rule helps the child rise to the initial conventional stage: being obedient because he wants to be praised and maintaining relationships. The collaboration makes the “garden” train the theory of the mind: the child realizes that SF has different ideas from TN, and the two must be negotiated.

Self-Confidence and Anxiety Reduction: Bandura 1977

Bandura stated that the experience of mastery is the strongest source of self-efficacy. When the SF subject successfully presents his work, he experiences mastery. This experience is generalized to another context: courage in the classroom. This is especially relevant after the pandemic, where the Ministry of Health in 2022 recorded a 27% increase in social anxiety in early childhood due to isolation. The loose part becomes a play therapy that restores courage.

Cognitive Impact: Creativity, Problem-Solving, and Language

The “creativity” score rose the most by +1.7. The child no longer waits for instructions, but makes a “cake”, a “car”, a “necklace”. This is a different kind of thinking. The activity of compiling ABAB patterns also trains early counting skills. During play, the child's vocabulary

increases: “bigger”, “smaller”, “above”, “below”. Thus, the loose part is cross-domain media.

Analysis of Gender, Individuality, and Differentiation

Gender Analysis

The N=12 data showed no significant difference in mean gains between 6 boys and 6 girls. However, the style of play is different. Boys tend to build: “towers”, “car roads”. Daughters for aesthetics: “necklaces”, “flowers”. The loose part is gender-neutral because it doesn't give a label. It supports the principle of gender equality from an early age and avoids the stereotype of “male-female toy”.

Individuality and Differentiation

The strength of the loose part can be adjusted. AN subjects with very weak motor skills were given a large substance: bottle caps. RD subjects who are already proficient are given a challenge: to come to terms with the ABC pattern. This is a differentiation according to the ZPD of each child, something that is difficult to do with a uniform LKA.

Policy Implications: Independent Curriculum, P5, SDGs 4, Stunting, and Islam

Independent Early Childhood Education Curriculum and P5 Project

The Merdeka Curriculum places play as an approach. The P5 theme “Play and Exploration” demands projects that: 1) Are child-interest-based, 2) Open, 3) Assess the process. Loose parts meet all. The assessment must change: from the “can/can't” check to the process rubric and photo portfolio.

Contribution to SDGs 4.2 Quality Education

The target of SDGs 4.2 is access to quality early childhood education for all. The main obstacle to PAUD in Indonesia is the cost of APE. A set of plastic APE can be 3-5 million. Loose parts from scrap materials cost <200 thousand. The “Material Alms” program involves parents to collect bottle caps. This makes PAUD of inclusive and fair quality.

Non-Nutritional Interventions for Stunting Prevention and Treatment

The Ministry of Health 2023 in the National Strategy for the Acceleration of Stunting Reduction emphasizes that stunting = poor nutrition + poor stimulation. Stunted children

have a 2.3 times greater risk of experiencing motor developmental delays. The loose part is cheap stimulation interventions that can be carried out in Posyandu and PAUD. The movement of picking seeds trains the muscles of the hands to eat on their own, thus increasing the independence of the dwarf child.

Integration of Islamic Values and Aksana Saki Character

As Aksana Saki Kindergarten, Islamic values are integrated: 1) Tafakur: “Look, son, Allah created stones with different shapes”. 2) Patience and Perseverance: The Meronce 20 button requires patience. 3) Thaharah and Hygiene: Wash the materials every Friday. 4) Gotong Royong: Sharing materials. With this, the loose parts become a medium for Islamic character education, not just motorcycles.

Implementation Challenges, Limitations, and Research Agenda

Challenges and Mitigations

Parental Perception: The assumption of “play does not learn”. Mitigation: parenting classes, portfolio exhibitions, motorcycle writing linkage education.

Safety: Risk of consumption. Mitigation: SOP size >3 cm for 3 years old, “no mouth” rule, weekly washing of materials.

Teacher Competence: Exemplary reflexes. Mitigation: IHT by HIMPAUDI, 3 months of mentoring, good practice video.

District 3T: Rare container materials. Mitigation: maximize local natural materials: stones, seeds, bamboo, fronds.

Research Limitations

1) Single case N = 12, limited generalization; 2) Uncontrollable, threat of ripening; 3) Duration 3 months, no retention; 4) Researcher bias as a participant.

Future Research Agenda

1) Multi-site RCTs with N>100; 2) A 3-year longitudinal study to see the correlation between motor skills at the age of 4 and writing ability in grade 2 of elementary school; 3) Simple fMRI/EEG studies to see the activation of the cerebellum when the part is loose; 4) Development of MOOC loose parts teacher training; 5) Comparative study of natural vs artificial loose parts.

Conclusion

This case study research aims to explore and describe in depth the effect of the application of loose media on the improvement of fine motor skills of children aged 5-6 years in Aksana Saki Kindergarten. Based on the results of participatory observation over 12 weeks or 36 sessions, interviews with teachers and parents, and photo and video documentation, the study reached several key conclusions.

First, loose section media has been shown to be significantly effective in improving fine motor skills of children aged 5-6 years. Empirical evidence shows an increase in average gains on five indicators: tripod grip +1.3 points, eye-hand coordination +1.5 points, accuracy +1.4 points, task endurance +1.4 points, and creativity +1.7 points. Qualitatively, there was a fundamental change from the palmar grip to the tripod grip in 10 out of 12 children. A decrease in seed spillage rate from 60% to 15% and an increase in focus duration from 7 minutes to 18 minutes indicate improved force modulation control, visual-motor coordination, and executive function. This effectiveness is explained through the lens of Piaget's theory of Constructivism which emphasizes the repetition of meaningful schemas, Nicholson's Theory of Variability which emphasizes the importance of environmental variables, as well as neuroscientific findings on the activation of the motor-cerebellum-prefrontal cortex pathway. Thus, the loose section serves as a “gymnasium for the hands and brain” that trains the intrinsic muscles of the hand while strengthening the neural connections that underlie writing readiness.

Second, the success of the intervention is largely determined by the role of the teacher as a facilitator, not an instructor. This study confirms the relevance of Vygotsky's 1978 Proximal Development Zone theory. Teachers who apply verbal scaffolding in the form of open-ended questions, provide space for exploration, and gradually fade, succeed in guiding children to achieve independence. The child-initiated learning principles from NAEYC 2020 are also evident. In Phase 3, children can collaborate to create a “garden” without the teacher's direction, which shows the emergence of creativity, negotiation, and theory of thought. These findings provide a practical answer to the dilemma of early childhood education teachers: how to meet the demands of elementary school readiness without conducting calistung exercises prohibited by Permendikbudristek No. 5/2022. The loose section becomes a safe and fun “pre-writing” bridge.

Third, the impact of the loose section is holistic and cross-domains of development. In addition to motor, the study found a significant increase in independence, according to Erikson's “Initiative vs. Guilt” stage. The social-emotional aspect develops through the “ingredients for all” rule that trains empathy and sharing. Children's confidence increases, as evidenced by the 10 silent children who dared to attend, which is relevant for recovering post-pandemic social anxiety. The cognitive aspect is stimulated through the preparation of ABAB patterns as the basis for initial algebra and numeracy. The language aspect develops

through the presentation of the work and the improvement of spatial vocabulary. Thus, the loose part is an efficient cross-curricular medium.

Fourth, the loose part is the media that is inclusive, economical, and contextual with Indonesian culture. There is no significant difference between boys and girls, so this media is gender-neutral. The use of local materials such as Code Kali stones and randu seeds instills local wisdom. From an economic point of view, the initial cost <Rp200,000 for 12 children, saves 94% compared to plastic APE. This is a solution for PAUD with limited APBS, while supporting SDGs 4.2 on access to quality education. In the context of Aksana Saki Kindergarten, the integration of Islamic values through tafakur, patience, taharah, and mutual cooperation makes a loose part as a medium for building Islamic character.

Fifth, this research has limitations that need to be acknowledged. A single case design with $N = 12$ and without a control group limits the ability to generalize and infer causal. The duration of 3 months has not been able to measure long-term retention of writing skills in elementary school. The role of the researcher as an observation participant also has the potential to cause bias. Therefore, follow-up studies with multi-site randomized controlled trial designs, longitudinal studies, and neurophysiological measurements are recommended.

Overall, this study concludes that the loose part is an effective, cheap, inclusive, and aligned pedagogical intervention with the Independent Early Childhood Curriculum to optimize the golden period of 0-6 years. Practical recommendations are: 1) Teachers need to be trained through 5-day modules on the principles of open play and rubric assessment, 2) Schools need to provide permanent “Loose Parts Corners” with safety SOPs, 3) Parents are involved through the “Material Alms” program, and 4) The Education Office needs to make this practice a model to be disseminated. If implemented systematically, the loose part has the potential to become one of the national strategies to improve the quality of early childhood education and prepare the Golden Indonesia generation 2045.

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Declaration on the Use of Artificial Intelligence

The authors declare that Claude.ai (Anthropic) was used solely to assist with language editing, grammar correction, and improving the readability of this manuscript. The AI tool did not contribute to the study design, data collection, data analysis, interpretation of results, or the formulation of the conclusions. All scientific content and final decisions regarding the manuscript were made by the authors, who accept full responsibility for its accuracy, integrity, and originality.

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