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Fostering Critical Thinking in Early Childhood: An Experimental Study on Loose Parts Media in Kindergarten

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ABSTRACT

Critical thinking, a higher-order cognitive skill, is essential in forming reliable decisions. In early childhood education, integrating developmentally appropriate methods such as Loose Parts play has the potential to foster creativity and critical thinking. This study explores the impact of Loose Parts media on the critical thinking abilities of children aged 5–6 years at Tunas Harapan Kindergarten, Tambang District, Kampar Regency. A quasi-experimental design with a pretest-posttest control group structure was employed. The sample consisted of 20 children divided equally into an experimental group (n=10) and a control group (n=10). The experimental group engaged in activities involving Loose Parts, while the control group followed conventional methods. Critical thinking skills were assessed before and after the intervention. Analysis using ANOVA revealed a significant improvement in the critical thinking skills of the experimental group. The calculated F-value was 6.122, with a significance value of 0.024 (df = 1, α = 0.05). These results indicate a statistically significant effect of Loose Parts media on the development of critical thinking. The findings support the hypothesis that Loose Parts play promotes critical thinking in early learners. The significant difference observed highlights the potential of this approach as an effective educational strategy in early childhood development.

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1. INTRODUCTION

Early childhood is recognized as a critical phase in human development, serving as the foundation for lifelong learning and cognitive growth. It is a period marked by rapid neurological and psychological changes that shape a child's future capabilities (Huliyah, 2017; Trenggonowati & Kulsum, 2018). During these formative years, children acquire essential skills across various domains

including moral values, culture, language, emotional regulation, and cognitive functioning (Rakimahwati, 2012). Among these, cognitive development stands out for its profound influence on a child's ability to think critically, solve problems, and engage with the world around them (Pransiska, 2018).

Critical thinking, a core component of higher-order cognitive skills, is not merely about answering questions but involves the ability to reason logically, assess situations, and make informed decisions. It encompasses the skills necessary to evaluate information, draw reasoned conclusions, and apply knowledge in real-world contexts (Azizah et al., 2018; Lismaya, 2019). These abilities are essential not only for academic success but also for personal growth and societal participation (Oner & Aggul, 2022; Živković, 2016). In this regard, schools and early childhood educators play a pivotal role in nurturing these thinking habits (Thayer-Bacon, 2020).

While various teaching methods and strategies exist to support cognitive development, recent pedagogical shifts have emphasized more interactive, student-centered learning environments. Among these innovations is the use of Loose Parts—a concept introduced by architect Simon Nicholson in the 1970s. Loose Parts are open-ended materials that can be manipulated, arranged, and transformed by children in myriad ways, thereby promoting creativity, critical thinking, and problem-solving skills (Nicholson, as cited in Daly & Beloglovsky, 2015). In early childhood settings, these materials often include natural elements such as stones, leaves, and twigs, or recycled items like buttons and fabric, which encourage tactile engagement and independent discovery (Hughes, 2010).

The integration of Loose Parts into Early Childhood Education (ECE) curricula has been linked to numerous developmental benefits. Research shows that such environments support cognitive, emotional, and social development, while also enhancing fine motor skills (Flannigan & Dietze, 2018; Gibson et al., 2017; Smith-Gilman, 2018). More significantly, Loose Parts provide children with hands-on exploration opportunities that foster curiosity and deepen conceptual understanding (Casey et al., 2016). Additionally, studies by Imamah and Muqowim (2020) and Najamuddin et al. (2022) highlight the effectiveness of STEAM-based Loose Parts activities in promoting critical thinking and problem-solving skills in children aged 5 to 6 years.

Despite growing evidence on the benefits of Loose Parts in promoting general developmental outcomes, there remains a significant research gap in understanding its specific impact on the cultivation of critical thinking skills in preschool-aged children. Most existing studies focus broadly on creativity or problem-solving within a STEAM framework, often overlooking critical thinking as a distinct, measurable outcome. Furthermore, few empirical investigations have been conducted in the Indonesian context, particularly in rural or under-researched regions like Tambang District. This study aims to fill that gap by empirically assessing how the use of Loose Parts media influences critical thinking in 5–6-year-old children within a local kindergarten setting.

In alignment with the purpose of this study—to examine the impact of Loose Parts-based learning on the critical thinking abilities of young children—this research is guided by several key questions. These questions are formulated to explore the relationship between the use of Loose Parts and the development of higher-order thinking skills in early learners. First, does the use of Loose Parts media significantly influence the critical thinking skills of children aged 5–6 years compared to those who engage in traditional learning methods? This question aims to identify any measurable difference between experimental and control groups. Second, which specific aspects of critical thinking (e.g., reasoning, problem-solving, analysis) are most affected by the implementation of Loose Parts activities? This inquiry seeks to determine whether certain cognitive domains are more sensitive to this pedagogical approach. Lastly, how do teachers and children interact with Loose Parts during the learning process, and how do these interactions facilitate or hinder critical thinking development? Through these research questions, the study aims to generate empirical insights into both the efficacy and the mechanisms by which Loose Parts may enhance critical thinking in early childhood education.

This research holds substantial educational significance. First, it contributes to the theoretical framework of critical thinking development in early childhood, offering a culturally and contextually

relevant examination. Second, it provides empirical evidence for educators and curriculum developers seeking innovative, play-based strategies to enhance cognitive skills. Third, the findings can inform policy recommendations regarding early childhood pedagogy in Indonesia and similar educational settings. Ultimately, equipping children with critical thinking skills at an early age empowers them to become adaptable, innovative problem-solvers capable of thriving in a rapidly changing world (Wolff et al., 2020).

2. METHOD

This study employed a quasi-experimental research method using a Pretest-Posttest Group Design. In this design, data collection was carried out at two points: prior to the intervention (pretest) and after the intervention (posttest). The purpose of these assessments was to measure changes in the participants' critical thinking abilities resulting from the experimental treatment. By comparing the pretest and posttest results, the study aimed to determine the effectiveness of the Loose Parts-based activities in enhancing children's critical thinking skills.

Table 1. Research Design Layout

Pre-test	Treatment	Post-test
A_1	O	A_2
A_3		A_4

Description

- **A1**: Measurement results of children's critical thinking skills before using Loose Parts.
- **A2**: Measurement results of children's critical thinking skills after using Loose Parts.
- **O**: Implementation of Loose Parts.
- **A3**: Measurement results of children's critical thinking skills before the control class intervention.
- **A4**: Measurement results of children's critical thinking skills after the control class intervention.

The research sample consisted of two groups: an experimental group of 10 students using Loose Parts media and a control group of 10 students using worksheets. The study was conducted at Tunas Harapan Kindergarten in Tambang District, Kampar Regency. Data collection was carried out using observations and a critical thinking assessment sheet as the instrument. The reliability of the instrument was tested using Corrected Item-Total Correlation and Cronbach's Alpha. Data analysis techniques included prerequisite tests (normality and homogeneity), the Wilcoxon test (to compare pretest and posttest scores within each treatment group), and the Mann-Whitney test (to compare pretest and posttest scores between the treatment groups).

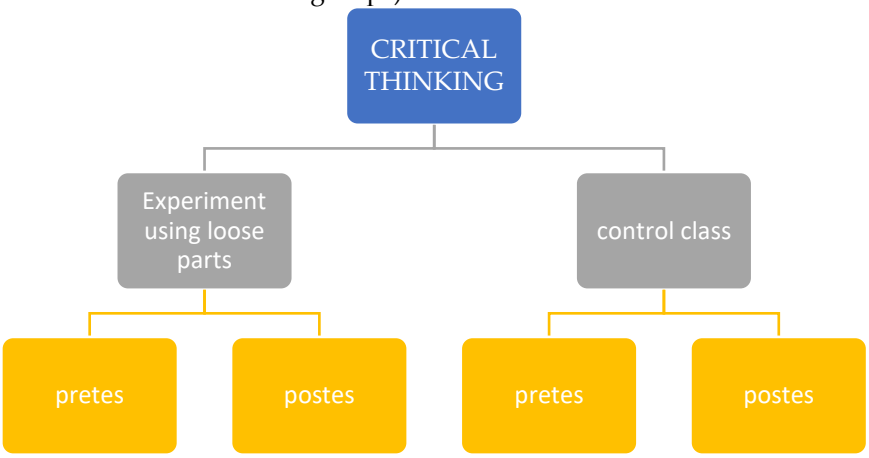

Figure 1. Research design

3. FINDINGS AND DISCUSSION

The study was conducted at Tunas Harapan Kindergarten, located in Tambang District, Kampar Regency. The research subjects consisted of 20 children aged 5–6 years, divided into two groups: 10 children in the experimental group (Class B1) and 10 children in the control group (Class B2). To ensure the quality and accuracy of the measurement instruments, several statistical tests were employed. Instrument validity was assessed using the product-moment correlation, while reliability was tested using Cronbach's alpha. The normality of the data distribution was examined using the Kolmogorov-Smirnov test, and data homogeneity was verified through Levene's test. For the final analysis, the data were processed using Analysis of Variance (ANOVA) to determine the significance of differences between the groups.

3.1 Instrument Testing

The testing of research instruments included validity and reliability tests. The data used in this study aimed to assess the validity and reliability of critical thinking observation data at non-sample institutions. These tests were conducted to determine the level of validity and reliability before being utilized in the research. The SPSS 23 for Windows program was used to test the effectiveness of the research instruments using product-moment correlation analysis.

Before conducting validity testing at Tunas Harapan Kindergarten in Tambang District, Kampar Regency, the research instruments were pretested. Based on the validity test, 18 statement items for the Loose Parts experiment and 10 items for critical thinking development were found to be valid, with a correlation coefficient of 0.632 and a sample size of N=10.

Table 2. Results of Critical Thinking Instrument Analysis of Loose Parts Experiment

Indicator number	r count	r table	Information
1	0,909	0,632	Valid
2	0,796	0,632	Valid
3	0,928	0,632	Valid
4	0,928	0,632	Valid
5	0,928	0,632	Valid
6	0,881	0,632	Valid
7	0,881	0,632	Valid
8	0,881	0,632	Valid
9	0,881	0,632	Valid
10	0,928	0,632	Valid

It can be concluded that validity refers to the accuracy of the research results in relation to what is being studied, with no doubts or falsifications; everything obtained by the researcher is reported as it is. Additionally, an instrument is considered valid if it can reveal data from the variable being studied.

This study conducted a reliability test using SPSS 23 at a significance level of 0.05. An instrument is deemed reliable if the Cronbach's alpha value is greater than the r-table value. The reliability test results for the Critical Thinking instrument in the science experiment showed a Cronbach's alpha value of 0.949 with a sample size of n=10 and an r-table value of 0.632. Since the reliability value (0.949) > r-table (0.632), the instrument is considered reliable. Similarly, the reliability test for the Critical Thinking instrument in the Loose Parts experiment yielded a Cronbach's alpha value of 0.972 with a sample size of n=10 and an r-table value of 0.632. Since the reliability value (0.972) > r-table (0.632), it can be concluded that the indicators in the instrument are reliable.

3.2 Critical Thinking Results in the Control and Loose Parts Groups

The critical thinking data of children was collected from a total of 10 respondents. Below is the detailed data on the critical thinking skills of children at Tunas Harapan Kindergarten, Tambang

District, Kampar Regency. The data is categorized based on the predetermined criteria, as presented in the following table :

Table 3. Frequency Distribution of Control Class Critical Thinking Pre-test

Intervals	Criteria	Frequency	Percentage (%)
19 - 21	Very Low	2	20
21 - 23	Low	4	40
24 - 26	Medium	3	30
27 - 29	High	1	10
≥30	Very high	0	0
Total		**10**	**100 %**

Based on Table 2, the results of the pre-test in the Control Class at Tunas Harapan Kindergarten, Tambang Subdistrict, Kampar Regency, Class B2, show that the majority of children have critical thinking skills categorized as low. This is evident from the total sample of 10 children, where two children (20%) fall into the very low critical thinking category, four children (40%) are in the low category, and three children (30%) are in the moderate category. Meanwhile, only one child (10%) is categorized as having high critical thinking skills.

Furthermore, the description of children's critical thinking data in the Loose Parts Class at Tunas Harapan Kindergarten, Tambang Subdistrict, Kampar Regency, is presented in Table 3 as follows:

Table 4. Frequency Distribution of Pre-Test Critical Thinking in the Loose Parts Class

Intervals	Criteria	Frequency	Percentage (%)
19 - 21	Very Low	4	40
21 - 23	Low	0	0
24 - 26	Medium	4	40
27 - 29	High	2	20
≥30	Very high	0	0
Total		**10**	**100 %**

Based on the data presented in Table 3, the results of the pre-test conducted in the experimental class (Class B1) at Tunas Harapan Kindergarten, Tambang Subdistrict, Kampar Regency, indicate that the majority of children demonstrated low levels of critical thinking skills. Four of the 10 children assessed (40%) were categorized as having very low critical thinking skills, while another 4 (40%) fell into the low category. Only three children (30%) were classified as having moderate critical thinking abilities, and just two children (20%) showed very high levels of critical thinking. These findings suggest that prior to the Loose Parts intervention, critical thinking skills in the experimental group were generally underdeveloped.

Following this, a post-test was conducted in the control class, which consisted of 10 children who did not participate in the Loose Parts activities. Instead, the children engaged in teacher-led play involving blocks, Legos, and puzzles. The results of this post-test, along with the distribution of critical thinking skill levels observed in the control group, are summarized in Table 4. These findings provide a comparative basis for evaluating the impact of Loose Parts media on children's critical thinking development in early childhood education.

Table 4. Frequency Distribution of Post-Test Critical Thinking in the Control Class

Intervals	Criteria	Frequency	Percentage (%)
19 - 21	Very Low	0	0
21 - 23	Low	0	0
24 - 26	Medium	2	20
27 - 29	High	5	40
≥30	Very high	3	40
Total		**10**	**100 %**

According to Table 4, the post-test results for the control class (Class B2) at Tunas Harapan Kindergarten, Tambang Subdistrict, Kampar Regency, show that the majority of children exhibited high levels of critical thinking skills. Among the 10 children assessed, two children (20%) were categorized as having moderate critical thinking abilities, five children (50%) were identified as having high critical thinking skills, and three children (30%) demonstrated very high critical thinking skills. These results suggest that although the control class did not engage in Loose Parts activities, traditional materials such as blocks, Legos, and puzzles still provided some opportunities for cognitive development, particularly in fostering higher-level thinking.

In contrast, the experimental group participated in two sessions of structured Loose Parts activities designed to stimulate critical thinking. During the first session, children were tasked with constructing multi-story buildings using an array of repurposed materials, including milk cartons, twigs, shampoo bottles, cardboard, pebbles, and PVC pipe segments. The activity began with the researcher presenting a video to introduce the concept of multi-story urban buildings. This was followed by a guided discussion where children observed and analyzed the shapes, functions, and sizes of real-world buildings. The teacher then encouraged the children to become "little architects" and use the provided materials to create their own structures. As they worked, the researcher posed thought-provoking questions such as, *"How will you create doors or windows for your building?"* to promote problem-solving and decision-making. At the end of the session, a group reflection was conducted, allowing children to share what they enjoyed or found challenging while the teacher offered encouragement and acknowledged their efforts.

In the second session, the focus shifted to creating a zoo enclosure using a wide variety of Loose Parts. Materials included toy animals (e.g., elephants, lions, giraffes), popsicle sticks, rubber bands, cardboard boxes, bamboo skewers, straws, dried leaves, pebbles, sand, fabric pieces, and bottle caps. These items were used to design roads, fences, bridges, and enclosures. Children were encouraged to handle and explore the materials freely before being challenged to design a zoo that included separate enclosures for at least three different animal species. The teacher facilitated the activity by asking open-ended questions to provoke curiosity and deeper thinking. After the creative session, a post-test was conducted—alongside the classroom teacher—to assess the children's critical thinking progress following their engagement with Loose Parts activities. The resulting data are presented in the subsequent table.

Table 5. Frequency Distribution of Post-Test Critical Thinking in the Loose Parts Class

Intervals	criteria	Frequency	Percentage (%)
16 - 18	Very Low	0	0
19 - 21	Low	0	0
22 - 24	Medium	0	0
25 - 27	High	3	30
≥28	Very high	7	70
Total		**10**	**100 %**

Based on Table 5, the results of the Post-Test in the Loose Parts Class at Tunas Harapan Kindergarten, Tambang Subdistrict, Kampar Regency, Class B1, show that 3 children (30%) fall into the high critical thinking category, while seven children (70%) fall into the very high critical thinking category. To observe the development of critical thinking in the Loose Parts Class at Tunas Harapan Kindergarten, Tambang Subdistrict, Kampar Regency, Class B1, the Pre-Test and Post-Test results can be explained in Figure 2 as follows:

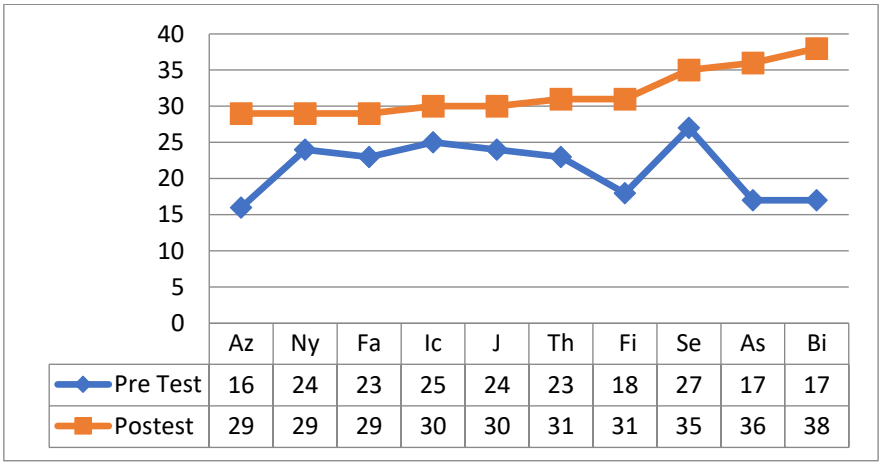

Figure 2. Pre-Test and Post-Test Critical Thinking Results Based on Loose Parts

Based on Figure 2, it can be seen that there is a difference in the development of critical thinking among the children at Tunas Harapan Kindergarten, Tambang Subdistrict, Kampar Regency, using Loose Parts, from the 10 children who received the treatment.

3.3 Hypothesis Testing Requirements

3.3.1 Normality Test

The purpose of the normality test is to determine whether the sample data comes from a population with a normal distribution. Good and valid data for use in this research are those that follow a normal distribution. In this study, the researcher used the Kolmogorov-Smirnov test for the normality test. The results of the Kolmogorov-Smirnov test are as follows:

Table 6. Normality Test

		Unstandardized Residual
N		10
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	2.32962872
Most Extreme Differences	Absolute	.131
	Positive	.119
	Negative	-.131
Test Statistic		.131
Asymp. Sig. (2-tailed)		.200

Based on the SPSS output in Table 6 above, it is shown that the significance value (Asymp. Sig.) is 0.200, which is greater than 0.05. Therefore, according to the decision-making criteria for the Kolmogorov-Smirnov normality test mentioned above, it can be concluded that the data are normally distributed. Thus, the assumption or requirement of normality in the regression model has been met.

3.3.2 Homogeneity Test

The homogeneity test is used to determine whether the data from the experimental class and control class have the same variance or not. The data are considered to have the same variance or to be homogeneous if the significance level is ≥ 0.05. Conversely, if the significance level is < 0.05, the data are concluded to have different variances or are not homogeneous. The results of the homogeneity test are as follows:

Table 7. Homogeneity Test

Levene Statistic	df1	df2	Sig.
1.094	1	18	.309

From Table 7, it can be seen that the calculation used in the homogeneity test with SPSS 23 resulted in a significance value (Sig.) of 0.309. Thus, since the significance value of 0.309 > 0.05, it can be concluded, based on the criteria, that the critical thinking development data from all sample groups have the same variance or are homogeneous.

3.3.3 Hypothesis Testing

Hypothesis testing was conducted using the two-way analysis of variance (ANOVA) technique.

Table 8. Analisis Varian (ANAVA)

	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	54.450	1	54.450	6.122	.024
Within Groups	160.100	18	8.894		
Total	214.550	19			

Table 8 presents the results of the ANOVA analysis for the learning model variable, where the calculated F-value ($F_h$itung) is 6.122, with a significance (Sig.) value of 0.024 at a degree of freedom (df) of 1 and an alpha level (α) of 0.05. According to the criteria for hypothesis testing using ANOVA, a significance value less than 0.05 indicates a statistically significant difference. Thus, it can be concluded that the use of Loose Parts has a meaningful effect on the development of children's critical thinking skills.

Further analysis revealed that the science experiment activity yielded a significance value of 0.038, and the Loose Parts intervention produced a significance value of 0.024—both below the 0.05 threshold. These results support the acceptance of the alternative hypothesis (H_1), confirming that the application of Loose Parts-based learning significantly impacts the development of critical thinking in early childhood. Moreover, the comparison of pre-test and post-test scores showed a clear increase in the post-test mean, indicating a measurable improvement in children's critical thinking abilities following the intervention. Therefore, it can be concluded that incorporating Loose Parts into early learning activities effectively enhances young children's capacity for critical thinking.

Discussion

The findings of this study indicate a notable improvement in children's critical thinking skills following the implementation of the Loose Parts learning model. Prior to the intervention, the average critical thinking score was 21.4, which fell within the low category. However, after the introduction of Loose Parts activities, the average score increased to 31.8, demonstrating a significant enhancement in cognitive engagement and higher-order thinking. This aligns with previous studies, such as Yeni's research, which found that STEAM-based learning incorporating Loose Parts effectively improves the cognitive abilities of children aged five to six. Rianti et al. (2022) also recommend the continued application of this approach to enhance children's learning outcomes, especially in problem-solving, logical reasoning, and symbolic thinking.

The effectiveness of Loose Parts activities is particularly evident in their ability to support cognitive development through problem-solving. These activities require children to engage in deep thinking, evaluate options, and make decisions—skills that are also foundational to creativity (Muanah et al., 2024). Loose Parts learning is highly appropriate for early childhood education, where

multisensory engagement is essential. Children naturally explore and understand the world through touch, movement, and manipulation. Loose Parts provide opportunities to combine, rearrange, redesign, and construct using a variety of everyday materials, encouraging curiosity and independent exploration (Gull et al., 2019).

Moreover, the use of Loose Parts not only promotes cognitive and creative development but also encourages environmental awareness. By incorporating everyday or recyclable materials, children learn the value of reusing and repurposing objects. This fosters early environmental stewardship while enriching their play experiences. As Gull et al. (2020) explain, Loose Parts creates dynamic and resource-rich environments that stimulate imagination and creativity. Beyond cognitive benefits, these activities also support the development of fine motor skills. As children grasp, manipulate, and construct with diverse materials, they naturally refine their hand-eye coordination and dexterity—critical components of physical development in early childhood (Aneli & Nurhafizah, 2023).

In conclusion, the findings affirm that the Loose Parts learning model is a powerful educational tool in early childhood settings. It not only enhances critical thinking but also supports a wide range of developmental areas, making it an effective, holistic approach to early learning.

Loose Parts can integrate all aspects of children's development, such as fostering and enhancing their creativity, particularly in critical thinking. In this study, this is demonstrated by children asking creative questions, solving problems, offering or accepting differing perspectives or opinions from their peers, and being courageous enough to take calculated risks, where the positive and negative impacts have been considered beforehand. This aligns with the findings of (Kholiyah et al., 2023) which indicate that Loose Parts media can improve problem-solving skills, creativity, concentration, fine motor skills, gross motor skills, science, language development, art, mathematical, logical thinking, engineering, and technology. Teachers can provide stimuli using a variety of materials and play tools to stimulate children's development and skills, helping them grow into individuals who consistently love and appreciate their environment.

Learning activities using Loose Parts can develop children's creativity and critical thinking skills. As stated by (Munawaroh et al., 2020), Loose Parts enable children to: 1) Develop the habit of asking questions during the learning process. When children ask questions, it signifies their curiosity and desire to learn, which can be categorized as critical thinking. 2) Utilize a variety of materials or loose items that can be moved, altered, and recombined in different ways. The flexibility in using these materials encourages creativity in children. 3) Use their imagination with the media or play tools prepared by the teacher in class. Teachers should avoid using phrases like "that's wrong," as labeling children's efforts as incorrect can hinder their creative imagination and exploration in learning activities with Loose Parts. 4) Build perspectives and form their own opinions. To develop this aspect, children need to learn how to assess an issue, formulate their opinions, and defend their viewpoints

In this study, the interaction using Loose Parts demonstrated an impact on children's critical thinking, as indicated by an F-value of 6.122 and a significance (Sig.) value of 0.024 at a degree of freedom (df) of 1 and alpha (α) of 0.05. According to hypothesis testing criteria through analysis of variance (ANOVA), the Sig. value is less than 0.05, indicating a significant difference in the development of children's critical thinking when using Loose Parts. Properly implemented learning activities using Loose Parts in early childhood education can have a significant positive impact, gradually enhancing children's logical and critical thinking abilities over time. Additionally, children will begin to learn about cause and effect from an early age, starting with the introduction of Loose Parts-based learning activities. Therefore, using Loose Parts can support children's reasoning processes in problem-solving.

4. CONCLUSION

This study concludes that the use of Loose Parts is an effective method for enhancing critical thinking skills in early childhood. The research findings demonstrate that children engaged in Loose

Parts activities showed improvements in key cognitive functions such as problem-solving, prediction, observation, and inference. These processes are fundamental to inquiry-based learning and are instrumental in fostering higher-order thinking. Furthermore, Loose Parts not only support critical and creative thinking but also promote collaborative skills and verbal communication among peers. The integration of Loose Parts into early childhood education enriches learning across multiple domains—encouraging mathematical reasoning through sorting and counting, scientific thinking through experimentation and prediction, and language development through storytelling and expressive play. However, this research is limited by its small sample size and the short duration of the intervention, which may not fully capture long-term developmental outcomes. Additionally, the study focused on a single kindergarten in a specific district, limiting its generalizability. Future research should consider longitudinal designs with larger and more diverse samples to better understand the sustained impact of Loose Parts on children's critical thinking. Further investigation into the role of teacher facilitation and environmental variables would also provide valuable insights into optimizing Loose Parts-based pedagogy.

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