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# Cognitive Development: Enhancing Classification Skills in 5- to 6-Year-Old Through Structured Manipulative Learning

Muqimah Surganingsih[1*], Azizah Amal[1], Nurul Indah Ramadani[2], Fadhilah Afifah[1], Febriana Ekananda Suras[3]

[1]Universitas Negeri Makassar, INDONESIA
[2]Universitas Islam Darud Da`Wah Wal-Irsyad A.G.H. Abdurrahman Ambo Dalle, INDONESIA
[3]Universitas Negeri Yogyakarta, INDONESIA

## Abstract

*Classification is a foundational cognitive skill required for early mathematics, yet children aged 5–6 years often struggle to transition from single-criterion to dual-criterion sorting due to cognitive centration. This study evaluates the effectiveness of a structured manipulative intervention, specifically the Shape and Color Sorting activity, in enhancing these skills. A quantitative approach with a pre-experimental, one-group pretest-posttest design was employed. Through total sampling, 20 children from Group B in Raudhatul Jannah Katangka Kindergarten were selected. Data gathered via structured pretest and posttest rubrics were analyzed using descriptive statistics, parametric assumption tests (normality and homogeneity), a paired samples t-test, and a simple linear regression analysis. Descriptive findings indicated substantial improvement in classification performance, shown by an increase in the mean conceptual score from 54.30 (±8.14) in the pretest to 66.95 (±7.63) in the posttest. The inferential analysis via a paired samples t-test confirmed this improvement was highly significant (t=3.632; df=19; p=0.001), proving that structured manipulative activities systematically reduced the children's cognitive centration. Furthermore, regression analysis demonstrated that initial baseline skills contributed 26.8% to the variance of posttest outcomes (R2=0.268; p=0.019). These findings conclude that structured manipulative activities are effective in expanding early childhood classification capacities. This study provides practical implications for early childhood educators to integrate multi-criteria manipulative sorting games within the curriculum to systematically support abstract logical reasoning and cognitive readiness.*

**Keywords:** classification skills; manipulative learning; cognitive Development; shape and color; early childhood.

* Corresponding author. *E-mail addresses*: muqimah.surganingsih@unm.ac.id

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## INTRODUCTION

Classification is widely regarded as a fundamental cognitive skill acquired during early childhood, serving as a critical prerequisite for advanced academic success. This ability the process of grouping and differentiating objects based on shared attributes is strongly correlated with the development of logical thinking, early mathematics, and scientific reasoning (Mcleod, 2025). Children aged 5–6 years are typically at a transitional stage where they can categorize based on salient perceptual features like color or shape (Türk dkk., 2026). However, real-world complexity often requires simultaneous classification based on multiple criteria (e.g., sorting only the small, red objects), a task many children at this age find challenging (Abbas & Jeong, 2024). Thus, early childhood learning must intentionally integrate structured, concrete activities to bridge this gap between single-criterion and dual-criterion classification.

The urgency for effective instructional strategies is highlighted by classroom observations. While classification holds significant educational value in Early Childhood Education (ECE) settings, practical application remains uneven. Observations at TK Raudhatul Jannah Katangka revealed that some children were able to sort objects based on a single criterion but struggled when two criteria were combined, indicating limited conceptual understanding and difficulties in applying prior knowledge. This problem aligns with broader literature emphasizing the need for structured instructional strategies over reliance on spontaneous or unstructured play alone (Bubikova-Moan dkk., 2019). Furthermore, many existing studies focus on media, play-based interventions, or unstructured sorting tasks without utilizing robust, measurable designs like pre- and post-test evaluations to accurately gauge conceptual gains, creating a critical research gap this study aims to address.

The current study is grounded in two seminal theories of cognitive development. Firstly, Piaget's theory of cognitive development posits that children aged 5–6 years are in the pre-operational stage, where their thinking is concrete and highly tied to perceptual features (Shabnam dkk., 2025). At this stage, children begin to classify objects but often exhibit centration, focusing on only one characteristic at a time when attempting to classify (Rabindran & Madanagopal, 2020). According to Piaget, cognitive growth is maximized when children are allowed to manipulate and experiment with real, concrete objects, enabling them to explore, test, and reorganize concepts (Rohmah dkk., 2022). This theoretical stance supports the importance of providing classroom activities that involve sorting and grouping concrete materials, as these hands-on experiences are crucial for moving beyond perceptual reliance.

Secondly, Vygotsky's sociocultural theory reinforces the importance of structure by emphasizing the role of guided learning and scaffolding in skill acquisition (Massa, 2024). Vygotsky argues that a child's cognitive abilities develop optimally within the Zone of Proximal Development (ZPD), where a more knowledgeable individual (e.g., a teacher or peer) provides instructional support (Veraksa dkk., 2022). Classification tasks become more effective when the teacher mediates the learning process by gradually introducing dual-criteria classification and encouraging children to articulate their reasoning (Ye & Xu, 2023). This mediated interaction is vital for achieving deeper conceptual understanding and facilitating the cognitive transfer of the sorting principle to new,

novel objects (Fredy dkk., 2026). This form of guided participation supports deeper conceptual understanding and cognitive transfer.

Existing research shows that classification activities have significant educational value in ECE settings. Children who participated in shape-and-color sorting activities demonstrated stronger logical thinking and better classification performance than children who learned classification through informal or incidental play (Kholifah & Darniati, 2025a). These findings are in line with other studies that highlight classification as a key component of cognitive readiness for school and early numeracy (St. Laurent dkk., 2021). Several empirical studies show that classification is not merely a perceptual skill but also a conceptual ability that contributes to logical reasoning, decision-making, and early mathematics (Hačatrjana & Namsone, 2024). For example, found that shape-and-color sorting activities enhance analytical thinking and help children distinguish categorical relationships among objects (Neuman & Kaefer, 2025). Other researchers have also documented that structured sorting enables children to develop systematic thinking patterns and enhances their ability to interpret visual cues.

The Indonesian early childhood curriculum reinforces the importance of developing logical thinking through hands-on, activity-based learning. National education regulations highlight classification as a core cognitive skill to be stimulated in ECE programs through direct interaction with materials, concrete learning experiences, and guided exploration (Fujiandri dkk., 2025). These curricular guidelines offer a relevant pedagogical framework for intervention (Asmayawati dkk., 2024). Recent studies in ECE highlight that the effectiveness of classification activities depends on their design (Nahak & Lestari, 2025). Classification tasks that incorporate concrete materials, teacher-guided explanations, and structured learning sequences have been shown to produce significant gains in children's classification performance (Twyman, 2021). Such approaches align with the cognitive development focus of the Merdeka Curriculum, which prioritizes active and concrete learning experiences to promote higher-order thinking skills in early childhood.

However, many early childhood classrooms still face challenges in strengthening children's classification ability. Observations at TK Raudhatul Jannah Katangka confirmed this gap in classroom practices: several children were only able to classify based on one criterion and displayed difficulties in sorting according to two criteria simultaneously. This indicates the need for structured learning designed specifically to improve classification ability rather than relying solely on spontaneous play or unstructured exploration. This problem is consistent with existing literature that emphasizes the need for structured instructional strategies rather than spontaneous play alone. Previous studies also show that classification tasks are not only related to perceptual processes but also involve higher-order thinking such as reasoning, decision-making, and analytical thinking. Empirical research shows that hands-on classification activities improve children's understanding of categorical relationships and strengthen systematic thinking. Nonetheless, many existing studies focus on media, play-based interventions, or unstructured sorting tasks without measuring conceptual understanding using pre- and post-test evaluation methods, limiting empirical evidence on structured techniques, particularly in classroom-based interventions with measurable outcomes.

Based on these considerations, this study examines the effect of structured shape-and-color sorting activities on the understanding of classification concepts in children aged 5–6 years. Unlike previous studies that primarily focused on unstructured play or the use of media, this research applies a measurable intervention design using pre- and post-test evaluations. The findings are expected to provide empirical evidence on the effectiveness of structured classification activities and to contribute practical recommendations for implementing concrete, activity-based learning strategies in ECE.

## METHOD

This study employed a quantitative approach using a one–group pretest–posttest design to measure the effect of classification activities on children's understanding of classification concepts (Creswell & Creswell, 2023). The intervention consisted of structured activities in which children grouped objects by shape and color using concrete materials. This design was selected because it enables measurable comparisons of the children's performance before and after the intervention (Baroody, 2017). The population consisted of all Group B children in Raudhatul Jannah Katangka Kindergarten. A total of 20 children participated in the study, and a saturated sampling technique was applied because the population size was small and all children were included as research subjects.

Data were collected using action-based tests (pretest and posttest) and direct observation during the intervention. The instruments were examined for validity and reliability to ensure that the data collected were accurate and trustworthy. The intervention was conducted over two weeks in small-group learning sessions. Children participated in concrete, play-based learning activities using real materials such as colored cards and building blocks. During the intervention, children were required to classify objects according to given criteria, progressing from single-criterion to dual-criterion sorting.

Pretest and posttest scores were analyzed using both descriptive and inferential statistics. Descriptive statistics were used to describe the minimum, maximum, mean, and standard deviation values. Inferential analysis began with a normality test using the Kolmogorov–Smirnov and Shapiro–Wilk tests (Mishra dkk., 2019). The results showed that the data were normally distributed, allowing the use of a paired sample t-test for hypothesis testing (Xu dkk., 2017). The study was conducted during regular classroom learning activities, and all research procedures were integrated into teaching practice without disrupting instructional time. The learning activities were designed to be developmentally appropriate, enjoyable, and aligned with the Merdeka Curriculum guidelines for ECE.

## RESULTS AND DISCUSSION

This study involved all students in Group B at Raudhatul Jannah Katangka Kindergarten, comprising a total of 20 children. The entire population was included as the sample using a total sampling technique due to the relatively small population size, which enabled the participation of all students. All participants completed both the pretest and posttest stages of the intervention, and therefore, no missing data were recorded. This allowed the complete dataset

to be analyzed to identify changes in the children's classification skills following the intervention.

The descriptive analysis revealed a noticeable improvement in classification skills after the implementation of the Shape and Color Sorting activity. The mean pretest score was 54.30 with a standard deviation of 9.073, while the mean posttest score increased to 66.95 with a standard deviation of 12.659. Furthermore, the score range increased from 41–72 in the pretest to 50–97 in the posttest. This increase of 12.65 points in the mean score indicates a positive development in the children's classification abilities. The rise in both the minimum and maximum scores further suggests that the improvement occurred across different ability levels.

**Table 1.** Descriptive Statistics of Pretest and Posttest

| *Statistic* | *Pretest* | *Posttest* |
|---|---|---|
| N (Number of Subjects) | 20 | 20 |
| Mean | 54.30 | 66.95 |
| Std. Deviation | 9.073 | 12.659 |
| Minimum | 41 | 50 |
| Maximum | 72 | 97 |
| Range | 31 | 47 |

The increase in the mean score from 54.30 to 66.95 indicates a positive improvement after the children participated in the classification activities using shape and color sorting. Before testing the hypothesis, prerequisite tests were conducted to ensure the appropriateness of using parametric statistical analyses. The normality test using Shapiro–Wilk showed that the pretest score had a significance value of 0.450 and the posttest score 0.177, both of which exceeded the significance level of 0.05. These results indicate that the data were normally distributed.

**Table 2.** Normality Test Results (Shapiro-Wilk)

| *Variable* | *Statistic* | *df* | *Sig. (p)* | *Interpretation* |
|---|---|---|---|---|
| Classification Concept (Pretest) | 0.955 | 20 | 0.450 | Normal (p > 0.05) |
| Classification Concept (Posttest) | 0.933 | 20 | 0.177 | Normal (p > 0.05) |

Additionally, the homogeneity test using Levene's Test showed a significance value of 0.340, which was greater than 0.05, confirming that the variances of the pretest and posttest scores were homogeneous.

**Table 3.** Homogeneity test

| *Basis* | *Levene Statistic* | *df1* | *df2* | *Sig. (p)* | *Interpretation* |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Based on Mean | 0.933 | 1 | 38 | 0.340 | Homogeneous (ρ > 0.05) |

Since both parametric assumptions were met, further analysis was carried out using a parametric mean difference test. A paired samples t-test was then conducted to determine whether the increase in scores from pretest to posttest was statistically significant.

**Table 4.** Paired Samples t-Test Results

| *Comparison* | *Mean Difference* | *t-value* | *df* | *Sig. (p)* |
|---|---|---|---|---|
| Pretest - Posttest | -12.65 | 3.632 | 19 | 0.001 |

The results revealed a t-value of 3.632 with a significance level of p=0.001, indicating that there was a statistically significant difference between the pretest and posttest scores. This suggests that the improvement in classification skills was not random, but rather the result of the structured Shape and Color Sorting activities provided during the intervention. Furthermore, a regression analysis was performed to examine the contribution of the pretest scores to the posttest scores.

**Table 5.** Model Regresi

| *Model* | *R* | *R Square (R2)* | *Adjusted R Square* | *Sig. F Change* |
|---|---|---|---|---|
| 1 | 0.518 | 0.268 | 0.228 | 0.019 |

The analysis showed a correlation coefficient (R) of 0.518 and an $R^2$ value of 0.268, demonstrating that 26.8% of the variance in the posttest scores was explained by the pretest scores. The significance value of 0.019 for the regression model indicated that the model was statistically valid.

**Table 6.** Regression Coefficients (Coefficients)

| *Model* | *Unstandardized Coefficient (B)* | *Std. Error* | *Sig. (p)* |
|---|---|---|---|
| (Constant) | 27.713 | 15.477 | 0.090 |
| Shape and Color Sorting | 0.723 | 0.281 | 0.019 |

The regression coefficient (B) of 0.723 with a significance value of 0.019 suggested a positive and significant relationship between the Shape and Color Sorting intervention and the improvement in classification abilities. Taken together, the results indicate that the Shape and Color Sorting activity had a positive and significant effect on the improvement of classification skills among children aged 5–6 years. The assumptions of normality and homogeneity were met, the mean difference was statistically significant as indicated by the ANOVA results, and the regression analysis confirmed that the intervention contributed meaningfully to the improvement in classification skills. These findings reinforce

the effectiveness of a manipulative-based learning approach in enhancing children's understanding of classification concepts.

The statistical findings demonstrate a clear and measurable advancement in children's cognitive processing after completing the structured manipulative intervention. Prior to the intervention, the baseline mean score of 54.30 reflected a common developmental hurdle: centration. Classroom observations confirmed that children could effortlessly sort blocks when isolated by a single attribute—such as separating all red objects regardless of their shape—but immediately faltered when asked to sort based on dual criteria, such as finding objects that were simultaneously small and red. This empirical baseline indicates that without formal mediation, children's classification logic remains heavily constrained by immediate perceptual dominance.

The substantial increase in the posttest mean score to 66.95, along with the expansion of the maximum score to 97, proves that manipulative-based learning acts as a cognitive catalyst. The physical act of grasping, rotating, and mapping multi-attribute objects forced a cognitive shift from passive perception to active representation. The true significance of this result lies in the transition toward decentration; children learned to mentally retain and process two distinct parameters—shape and color—at the exact same time. By shifting from a single-criterion focus to a dual-criterion operational framework, the children constructed the systematically and empirically structured mindsets required for early complex reasoning.

Theoretically, this finding is very much in line with Piaget's theory of cognitive development, which states that children in the pre-operational stage rely heavily on concrete experiences to build conceptual knowledge. Before the intervention, many children showed symptoms of "centrism," where they were only able to focus on a single physical characteristic, such as color, without paying attention to shape (Németh dkk., 2025). Through active manipulation of real objects, children are encouraged to engage in the process of decentering, namely the ability to consider two criteria simultaneously (for example, looking for an object that is both small and red). This process serves as a crucial bridge in the transition from perceptual thinking to more mature logical categorization.

In addition to the role of media, this success is also driven by the application of Vygotsky's sociocultural theory through the provision of scaffolding. This intervention does not allow children to play independently without direction, but rather involves the role of the teacher as a mediator who provides instructions, demonstrations, and guidance within the child's Zone of Proximal Development (ZPD) (Gibson dkk., 2021). This instructional support allows children to internalize classification concepts that were previously difficult for them to understand on their own. Thus, social interaction between teachers and children becomes an important mechanism in cognitive restructuring, especially for tasks requiring high-level conceptual reasoning.

The pedagogical implications of this study emphasize that early childhood teachers should not rely solely on spontaneous or unstructured play to develop children's logical abilities. Learning must be intentionally designed with a clear sequence, starting from single criteria to multiple criteria. This approach is highly relevant to Indonesia's Independent Curriculum guidelines, which prioritize active and concrete learning experiences to stimulate higher-order thinking skills (Zuva dkk., 2025). By mastering classification skills through manipulatives, children

build a strong foundation for early numeracy skills and academic readiness in subsequent levels of education.

Despite these positive results, this study also highlights the importance of developing future research designs. The use of a one-group pretest-posttest design has limitations in isolating purely causal effects due to the lack of a control group for comparison. Therefore, future research is recommended to use experimental designs involving control groups or longitudinal assessments to measure the extent to which the intervention's impact is sustained over the long term (Bierer dkk., 2025). Further development could also explore the use of other types of concrete media or implementation across different age groups to broaden the generalizability of these findings.

These results are directly aligned with Piaget's theory of cognitive development. Piaget (1952) argues that children aged 5–6 are still dependent on concrete experiences for constructing conceptual knowledge (Collins, 2010). During this preoperational stage, logical relationships cannot yet develop abstractly; they require active manipulation of physical materials. The structured sorting activities in this study enabled children to operationalize Piaget's notion of decentering, as they had to consider two attributes simultaneously rather than relying on a single perceptual cue. This phenomenon illustrates the transition between perceptual thinking and logical categorization, validating Piaget's claim that cognitive development is stimulated when children actively engage with real objects.

The results also provide empirical support for Vygotsky's sociocultural theory, which positions learning as a socially mediated activity. Vygotsky (1978) emphasized that cognitive advancement occurs when children are supported within their Zone of Proximal Development (ZPD), and that scaffolding is essential in bridging the gap between current and potential levels of understanding (Shabani dkk., 2010). In this study, the teacher's role in providing instructions, demonstrations, and prompts was instrumental in enabling students to internalize the classification concepts. Such instructional support demonstrates that social interaction is a critical mechanism for cognitive restructuring, particularly for tasks requiring higher-order conceptual reasoning.

Beyond validating classical cognitive theories, the findings also resonate with recent empirical studies that highlight the importance of hands-on, manipulative learning in early childhood. Research consistently shows that concretizing abstract concepts through sorting and categorizing strengthens children's conceptual foundations and enhances logical thinking (Donovan & Fyfe, 2022). This aligns with contemporary pedagogical shifts that emphasize active learning environments and multimodal instructional strategies. The observed improvements in classification ability thus reflect the broader consensus that experiential learning supports deeper cognitive processing. Moreover, the contribution of the intervention was not merely qualitative but quantitatively significant. The regression analysis indicated that structured shape-and-color sorting accounted for 0.268 of the variances in classification skills, providing clear evidence that this method contributes directly to concept development (Kholifah & Darniati, 2025b).

The primary contribution and novelty of this study rest on its empirical rigor within an Indonesian early childhood education (ECE) framework. A significant portion of existing early childhood literature remains predominantly qualitative,

descriptive, or overly reliant on tracking engagement metrics during play without assessing actual conceptual gains. This study fills this critical research gap by providing a measurable, pretest-posttest quantitative evaluation design to map the explicit trajectory of early cognitive growth under a structured curriculum. By aligning statistical progress directly with the active mandates of Indonesia's Merdeka Curriculum, this research offers an actionable, evidence-based instructional protocol. It mathematically demonstrates how structured, multi-attribute manipulative learning can successfully foster higher-order thinking skills (HOTS) in early childhood learners.

This confirms existing studies showing that structured classification supports numerical reasoning and early mathematical competence (Parviainen, 2019). The measurable impact further supports the argument that early exposure to classification tasks contributes to foundational academic readiness and later learning outcomes. A pedagogical implication emerging from these findings is the strategic value of integrating structured sorting tasks into early childhood learning. Teachers should not rely solely on spontaneous or informal play to develop classification ability. Instead, structured learning experiences with clear instructions, guidance, and scaffolding should be adopted as part of deliberate instructional design.

Despite the significant statistical results, several methodological limitations must be acknowledged when interpreting the scope of these findings. First, this study utilized a one-group pretest-posttest design without a parallel control group for baseline comparison, making it mathematically impossible to completely isolate external confounding variables—such as natural chronological maturation or incidental learning outside the classroom—from the true causal effects of the sorting intervention. Second, the research was restricted to a small sample size of 20 children within a single Group B classroom at Raudhatul Jannah Katangka Kindergarten. Although a saturated sampling approach was appropriate given the specific institutional parameters, these sample constraints lower the statistical power of the regression model and restrict data variance. Lastly, limited generalizability is a logical consequence of this restricted sample size and localized geographic context. Therefore, the findings cannot be broadly generalized to the highly diverse early childhood education environments across Indonesia, as variations in regional socioeconomic factors, baseline school facilities, and teacher training profiles may alter the intervention's efficacy when implemented outside this specific research site.

This study illustrates how shape-and-color sorting can promote reasoning, language development, and problem-solving skills, making it relevant not only for cognitive development but also for supporting broader learning competencies expected in early childhood education. In addition to validating existing theories and practices, the study also highlights the importance of teacher involvement and instructional framework. Children benefited most when activities were embedded within guided interactions rather than independent exploration alone. This finding reinforces the position that curriculum implementation in ECE should prioritize intentional teaching strategies involving dialogue, questioning, and reflection. Such structured intervention aligns closely with contemporary curriculum standards and supports the cultivation of higher-order thinking skills in early learners. Finally, the findings of this study open pathways for future research. Although the intervention significantly improved children's classification

skills, future studies should employ a control group design to isolate causal effects more rigorously and strengthen external validity (Creswell & Creswell, 2023). This refinement would ensure that the gains observed are not attributable to extraneous variables. Researchers might also consider extending the study across different age groups, school contexts, or types of classification tasks to explore the generalizability and scalability of the intervention. By doing so, the research community can contribute further evidence supporting the long-standing educational principle that structured, manipulative-based learning is an essential mechanism for cognitive development.

## CONCLUSION

This study demonstrates that the Shape and Color Sorting activity is an effective instructional strategy for improving early childhood classification skills. The improvement is reflected not only in the children's cognitive development but also in their ability to distinguish, categorize, and interpret objects based on multiple attributes. The manipulative-based intervention successfully provided concrete learning experiences aligned with the children's developmental stage, while also facilitating active engagement and educational interaction that support logical thinking. These findings emphasize the importance of structured instructional approaches that integrate concrete materials and teacher scaffolding as essential components of early childhood learning. Based on the results and discussion, this research expands the understanding of the effectiveness of shape and color sorting activities in developing children's thinking skills and provides both theoretical and practical foundations for educators to implement such strategies sustainably. Therefore, teachers are encouraged to optimize classification activities through varied, contextual, and child-centered learning in order to maximize children's cognitive growth. For future research, it is recommended to employ an experimental design with a control group or longitudinal assessment to measure the persistence of the intervention's impact. Further studies may also explore other types of concrete media or implementation in different age groups. The author expresses appreciation and gratitude to the school, teachers, and all parties who supported the implementation of this study.

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