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Improving Early Mathematics Skills Through Contextual Theme-Based Smart Box Media in Early Childhood

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Abstract

This classroom action research aims to improve early mathematics skills of Group B children at TK Desa Majasto 02 through the implementation of a contextual theme-based "Animals as God's Creatures" smart box media. The primary issue in this study is the children's low ability to comprehend number concepts, simple arithmetic operations (addition and subtraction), and match numbers with the corresponding quantity of objects. The research subjects consisted of 10 children (6 boys and 4 girls). The study was conducted in two cycles, with each cycle comprising planning, acting, observing, and reflecting stages. Data collection techniques employed structured observation and documentation, while data analysis was performed using descriptive comparative analysis. The results indicated a significant improvement in the children's mathematics skills. In the pre-cycle condition, the classical completeness of children's mathematics skills reached only 20% (2 children). Following the intervention in Cycle I, the completeness percentage rose to 50% (5 children) and achieved optimal success in Cycle II at 90% (9 children). These findings prove that utilizing concrete and manipulative smart box media can facilitate the transformation of abstract concepts into concrete understanding, as well as enhance children's active engagement in early mathematics learning.

Keywords: *Mathematics Skill; Smart Box; Early Childhood; Classroom Action Research.*

INTRODUCTION

Early Childhood Education (PAUD) serves as a critical foundation for a child's future development. Based on the Regulation of the Minister of Education and Culture (Permendikbud) Number 137 of 2014, the cognitive aspect—which encompasses mathematical ability is one of the crucial standards for the level of child development achievement. Wang & Hung (2020) Mathematical skills in early childhood include learning and simple problem-solving, logical thinking (classification, patterns, cause-and-effect), and symbolic thinking (understanding number concepts and numerals)(Preston et al., 2025; Svraka et al., 2024). Mathematical ability is not a skill mastered instantly; rather, it develops gradually through appropriate and meaningful stimulation processes (Lusida et al., 2024; Umi Rofiqoh & Muthmainnah, 2024). Optimal cognitive development during this golden age acts as a strong predictor of a child's academic success in elementary school (Ibrahim et al., 2025; Rahmah et al., 2023).

However, this ideal condition has not been fully realized in the field. Based on initial observations in Group B at TK Desa Majasto 02, Tawangsari District, Sukoharjo. Regency, the early mathematical abilities of the children were found to be low. Out of a total of 10 children observed, most experienced difficulties in understanding number recognition, performing simple addition and subtraction operations, and understanding the concept of pattern relationships. During counting activities, the majority of children were unable to correctly connect the number of objects with their corresponding numerals (Fleer et al., n.d.). Furthermore, children's attention was easily distracted; when the teacher provided apperception, most children tended to be passive and quiet, while several other children were actively moving around and disturbing their peers.

The root cause of this low mathematical ability was identified as originating from limited meaningful learning experiences for children, minimal use of manipulative learning media, and teacher instructional methods that tended to be monotonous. Many early childhood practitioners still rely on paper-based Student Worksheets (LKS), which are abstract in nature and quickly trigger boredom in children (Anastasia Desmeria Br Ginting et al., 2024; Irawan R. & Amirudin, 2023; Nugroho & Sari, 2022). Meanwhile, the cognitive characteristics of early childhood are within the pre-operational stage, which demands the presence of physical objects and concrete media so that abstract mathematical concepts can be well internalized (Aulet et al., 2025; Way, 2025).

As an alternative solution, an educational medium that is adaptive, interactive, and child-centered is required. One innovative medium that can be applied is smart box media. The smart box is designed as a manipulative square box where each side provides various types of educational games to deliver learning information in a concrete manner. This medium has the advantage of simplifying abstract concepts into real visualizations, stimulating sensorimotor skills, and increasing children's intrinsic learning motivation (Saputri et al., 2025; Yuniati, Rosita Andriani, 2017).

To maximize its effectiveness, the application of smart box media in this study was integrated thematically with the context of children's lives through the theme "Animals as God's Creatures". Through this theme, children were invited to manipulate miniature animal objects, count the number of animal legs, and match numerals on the sides of the smart box(Fu & He, 2025). Therefore, this classroom action research aims to analyze and describe how the application of smart box media can improve the early mathematical abilities of Group B children at TK Desa Majasto 02, Tawangsari District, Sukoharjo Regency.

METHODS

Research Design and Setting

This study utilized a Classroom Action Research (CAR) design based on the Kemmis and McTaggart model, which was implemented in a cyclical manner. Each cycle in this research consisted of four main stages: (1) planning, (2) acting, (3) observing, and (4) reflecting. The research was conducted at TK Desa Majasto 02, Tawangsari District, Sukoharjo Regency, Central

Java. The implementation of the research was scheduled for the First Semester of the 2024/2025 Academic Year, specifically between October and November, coinciding with the implementation of the independent curriculum (*Kurikulum Merdeka*) based on contextual themes.

Subjects and Data Sources

The subjects of this research were the students of Group B at TK Desa Majasto 02, totaling 10 children, consisting of 6 boys and 4 girls. The characteristics of this classroom featured high heterogeneity in terms of learning focus and initial cognitive abilities. Primary data sources were obtained directly from the research subjects (students) through performance assessments, while secondary data were sourced from the classroom teacher and the school principal through confirmation interviews.

Data Collection Techniques and Instruments

The data collection techniques used included:

1. Structured Observation: Used to capture the learning process, the level of child engagement, and the achievement of early mathematics indicators. Observation sheets were filled out by the researcher using scoring criteria based on evaluation rubrics.
2. Documentation: Included photographs of learning activities using the smart box, children's number-matching work, and daily lesson plans (RPPH).

Indicators of Success

Early mathematical ability was measured through three main indicators derived from the problem identification:

a. Indicator 1: The ability to understand number concepts through object counting activities (addition and subtraction).
b. Indicator 2: The ability to accurately match numerals with the corresponding quantity of objects.
c. Indicator 3: Interest and active engagement of children during mathematical concept recognition activities.

This research was declared successful if the percentage of classical completeness in children's mathematical abilities reached a minimum of 80%, with individual achievement criteria at least within the category of Developing as Expected (BSH) or Developing Very Well (BSB). Data analysis was performed using descriptive comparative techniques, specifically by comparing the percentage of completeness between cycles.

RESULTS AND DISCUSSION

Results

The implementation of classroom action research was carried out through three stages of data: the initial condition (pre-cycle), Cycle I, and Cycle II. The quantitative development of the mathematical abilities of Group B children at TK Desa Majasto 02 is summarized in the following table:

Table 1: Comparison of Children's Mathematics Skills Completeness Across Cycles

Developmental Condition	Achievement Criteria	Pre-Cycle	Cycle I	Cycle II
Not Yet Developing (BB) / Starting to Develop (MB)	Incomplete	8 children (80%)	5 children (50%)	1 child (10%)
Developing as Expected (BSH) / Developing Very Well (BSB)	Complete	2 children (20%)	5 children (50%)	9 children (90%)
Total Children		10 children	10 children	10 children
Classical Completeness Percentage		20%	50%	90%

(Sources: Research Data, 2025)

1. Initial Condition (Pre-Cycle)

In the pre-cycle stage, mathematics learning was still conventional without adequate manipulative media. The results showed a very low classical completeness rate, with only 20% or equivalent to 2 children reaching completeness. The majority of the children (8 children or 80%)

experienced confusion when asked to count pictures of animals and write their numerals on worksheets. The children also displayed signs of boredom and lost concentration after 10 minutes of the lesson commencing.

2. Cycle I

In Cycle I, the researcher began introducing the smart box media with the theme "Animals as God's Creatures". The smart box was placed in the middle of the classroom carpet to be played with in groups. Children were asked to take miniature animal objects (such as fish or chickens), count them, and then insert the corresponding number cards into the slots of the smart box.

Observation results from Cycle I showed an increase in classical completeness to 50% (5 children complete). Although children's interest began to grow significantly, several obstacles still arose. The children tended to scramble to play with the sides of the smart box due to limitations in group management, and two children still mistook the numerals 6 and 9 during the object-matching process.

3. Cycle II

Based on the reflections from Cycle I, the researcher made improvements in Cycle II by dividing the children into smaller, more organized groups and adding a wider variety of number pouch games to the sides of the smart box. The focus of stimulation was directed toward reinforcing simple addition and subtraction operations using the miniature animal objects directly.

The results of Cycle II showed a highly satisfying surge in performance, where classical completeness accelerated to reach 90% (9 children complete). The children were not only able to precisely match numerals with the quantity of objects, but they also demonstrated high interest and were able to solve simple subtraction operations without feeling pressured. Only 1 child remained in the Starting to Develop (MB) category due to absenteeism and motor development delays, requiring individualized treatment.

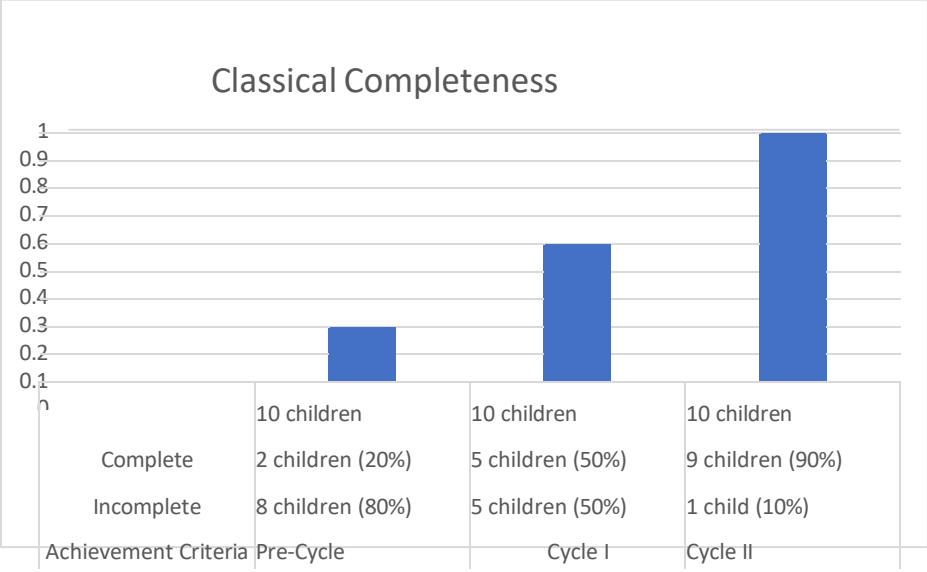


Figure 1. Frequency Distribution of Children's Early Mathematics Skills in the Pre-Cycle Phase
(Sources: Research Data, 2025)

Figure 1 presents the baseline assessment (pre-cycle) of the children's early mathematics skills before the implementation of the smart box media. The data reveals that the overall mathematical ability of Group B children at TK Desa Majasto 02 was
notably low. Out of 10 children observed, a striking majority of 80% (8 children) were categorized into the "Not Yet Developing" (Belum Berkembang - BB) and "Starting to Develop" (Mulai Berkembang - MB) stages, indicating that they faced significant difficulties in recognizing

numbers, executing simple arithmetic, and matching numerals with objects. Conversely, only 20% (2 children) reached the baseline of classical competence, falling into the "Developing as Expected" (Berkembang Sesuai Harapan - BSH) category, while none of the children achieved the "Developing Very Well" (Berkembang Sangat Baik - BSB) stage. These initial findings underscore the urgent need for an innovative and concrete manipulative medium, such as the contextual theme-based smart box, to stimulate and improve the children's cognitive and early mathematical development.

Discussion

The results of the study prove that smart box media is effective in improving early mathematical abilities in Group B children at TK Desa Majasto 02. This improvement occurred due to a shift in the learning paradigm, moving away from abstract-verbalistic approaches (oriented toward worksheets) toward concrete-manipulative learning (Fitriani et al., 2024). Masyripah & Masitoh (2025)In line with Jean Piaget's theory of cognitive development, children aged 5–6 years require representations of real objects to construct their mental structure of knowledge. In line with research conducted Puspita et al. (2023), children's thinking moves from thinking abilities dominated by visual perception to logical thinking abilities. Children actively build an understanding of the world. (Nuryati & Darsinah, 2021). Smart box media facilitates this need by providing a space for physical exploration where children can touch, slide, and count objects directly (Ardini et al., 2022; Kurniawan & Toharudin, 2024)

The integration of the contextual theme "Animals as God's Creatures" also contributed to the success of the action. Mathematical concepts presented through narratives of animal life are much easier to understand and attract children's intrinsic interest compared to rigid rows of numbers on a whiteboard (Clements & Sarama, 2003, 2021; Sarama, Julie and Clements, 2004) The children's emotional attachment to the animal theme allowed their attention span to last longer, ensuring that learning activities proceeded constructively without coercion (A. K. Hidayat et al., 2025; R. Hidayat et al., 2023)

Learning mathematics without manipulative media makes it difficult for children to associate numerals with actual quantities (Pratiwi et al., 2024). Therefore, the use of adaptive educational media such as the smart box is urgently needed to stimulate skills from an early age (Aizikovitsh-Udi & Cheng, 2015; Anggraeni Rusmia Putri et al., 2021; Fernández-Santín & Feliu-Torruella, 2020). Game-based media has proven to provide space for children to explore spatial concepts and geometric logic naturally (Afwanni & Pamungkas, 2024; Education et al., 2026; Kobandaha et al., 2025). When children are directly involved in manipulating objects within the game box, their focus and memory retention regarding mathematical material increase significantly (Astuti et al., 2023). This aligns with the principle that optimal cognitive stimulation during the golden age must be packaged in activities that are fun and free from formal pressure (Werle et al., 2026; Yolanda et al., 2023).

In addition to improving cognitive concept understanding, the use of the smart box proved capable of reducing disruptive behaviors among children during the learning process. The initial problem of children being passive or disturbing their peers was resolved because all children received a turn to be actively involved with the box media. Physical activity when inserting objects into the smart box simultaneously stimulates hand-eye coordination and visual-spatial abilities in children (Ningsih & Mulyani, 2023). Overall, this study reinforces previous theoretical findings that the well-designed utilization of manipulative educational game tools can optimize children's mathematical readiness for formal elementary education (Pradilla et al., 2025).

CONCLUSION

The application of smart box media based on the contextual theme "Animals as God's Creatures" is proven effective in improving the early mathematical abilities of Group B children at TK Desa Majasto 02, Tawangsari District, Sukoharjo Regency. The process of improvement is reflected in the surge of classical completeness from 20% in the pre-cycle stage, to 50% in Cycle I,

and peaking at 90% success in Cycle II. The smart box media successfully transforms the mathematics learning atmosphere from abstract and monotonous into a concrete, active, and enjoyable play activity for early childhood. It is recommended that early childhood practitioners widely adopt this media as a varied and child-centered cognitive stimulation instrument

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