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Analyzing the Impact of Block Play on Early Numeracy Acquisition in 4-to-5-Year-Old Children: A Qualitative Study

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Abstract

Early numeracy acquisition provides a crucial cognitive foundation for lifelong mathematical competence and analytical reasoning. However, instructional approaches in early childhood education frequently rely on abstract rote learning, failing to align with preschool cognitive developmental stages. This qualitative descriptive study analyzed the role of block play in fostering early numeracy skills among 23 children aged 4–5 years (11 girls, 12 boys) at RA Al-Hidayah. Data were gathered through semi-structured teacher interviews, direct non-participant classroom observations, and instructional documentation, and analyzed using the Miles and Huberman interactive qualitative framework. The findings demonstrate that block play significantly supports early numeracy indicators, including number-symbol recognition, 1-to-1 counting correspondence, relative magnitude discrimination (more vs. less), and spatial-numerical reasoning. From a neurocognitive perspective, manipulating physical blocks stimulates prefrontal cortex networks by bridging concrete sensory experiences with abstract visual-spatial memory. However, the study revealed that block play remains underutilized as a core instructional medium, often serving merely as an informal filler activity. Optimizing early numeracy requires integrating block construction systematically with multimodal learning resources, consistent attendance, and supportive home learning environments.

Keywords: *block play, early numeracy, early childhood education, concrete learning, cognitive development, neurocognitive stimulation*

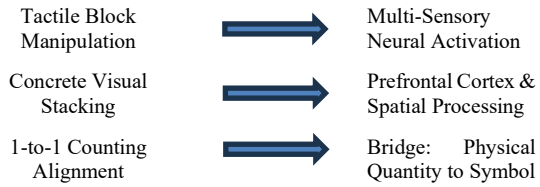
INTRODUCTION

Early numeracy skills represent a fundamental pillar of early childhood cognitive development. Between ages 4 and 5, young children naturally begin exploring numerical order, counting concrete objects, and comprehending basic spatial and quantitative relationships. Early mathematical competence not only prepares children for formal primary education but also strengthens logical reasoning, spatial visualization, and executive function capacities. Consequently, early childhood pedagogy must provide rich, age-appropriate numeracy stimulation tailored to children's developmental profiles.

According to Piaget's cognitive development theory, children aged 4–5 years operate within the preoperational stage, characterized by egocentric, intuitive thinking and a reliance on concrete perceptual experiences. Preoperational learners cannot fully process abstract mathematical symbols without direct physical manipulation of real-world objects. When mathematical concepts are presented solely through abstract worksheets or verbal repetition, children often memorize numerical sequences without understanding their underlying quantitative meaning. Furthermore, Vygotsky's social constructivism highlights that cognitive growth occurs through mediated interactions

within a supportive socio-cultural environment, where structured physical tools act as cognitive scaffolds.

From a neurocognitive perspective, early childhood represents a critical window of neuroplasticity. Developing executive functions—such as working memory, cognitive flexibility, and inhibitory control—is closely tied to the maturation of the prefrontal cortex. Tactile and spatial tasks, such as handling building blocks, simultaneously engage visual, motor, and spatial brain regions. This multi-sensory activation strengthens synaptic connectivity, laying the neural groundwork for abstract numerical reasoning and spatial-mathematical integration.



NEUROCOGNITIVE & DEVELOPMENTAL FRAMEWORK

Despite the recognized benefits of manipulative media, early childhood classrooms frequently encounter challenges in numeracy instruction. Many children struggle with matching numerical symbols to set quantities or comparing relative magnitudes due to overly abstract, non-interactive teaching methods. Building blocks offer an ideal, screen-free Educational Game Tool (*Alat Permainan Edukatif*) that transforms abstract counting into concrete, visual, and tactile experiences.

This qualitative study explores the implementation of block play and its specific role in developing early numeracy capacities among 4-to-5-year-old learners at RA Al-Hidayah.

RESEARCH METHODS

Research Design and Contex

This study utilized a qualitative descriptive research design to capture an in-depth, contextualized understanding of block play and numeracy development in a naturalistic preschool setting. The research was conducted at RA Al-Hidayah, Cihideung District, Tasikmalaya City.

Participants

The research participants comprised 23 children (11 girls and 12 boys) aged 4–5 years enrolled in Group A at RA Al-Hidayah, along with the primary classroom lead teacher who served as the key informant.

Data Collection Procedures

Data were gathered using three complementary qualitative techniques:

1. Semi-Structured Teacher Interviews: In-depth interviews were conducted with the lead teacher using an interview guide focused on numeracy curriculum design, block play frequency, observed child engagement, and individual developmental variations.
2. Classroom Field Observations: Non-participant observations were carried out during instructional sessions and unstructured play periods to record children's block stacking behaviors, counting initiation, spatial comparison, and peer collaboration.
3. Documentary Analysis: Lesson plans (*RPPH*), child development assessment records, and photo documentation of classroom play sessions were systematically reviewed to corroborate observational data.

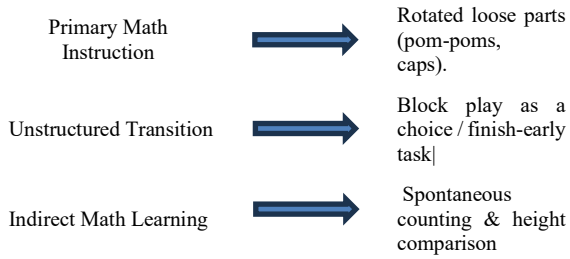
Data Analysis and Rigor

Data were analyzed following the interactive model of Miles and Huberman, comprising data reduction, narrative display, and thematic conclusion drawing. Data trustworthiness was maintained through method triangulation (cross-verifying interviews, observational notes, and documents) and member checking with the classroom teacher

RESULTS AND DISCUSSION

Implementation Dynamics of Block Play in the Classroom

The empirical findings reveal that while numeracy activities are scheduled regularly in the classroom curriculum, block play is rarely positioned as the primary instructional tool for math lessons. Instead, teachers frequently combine various concrete manipulatives—such as colorful pom-poms, bottle caps, and counting beads—to maintain novelty and visual appeal.



CLASSROOM BLOCK INTEGRATION DYNAMIC

Importantly, building blocks remain a favorite choice during transition periods and unstructured free play. Even when block play occurs informally, children spontaneously engage in foundational mathematical behaviors. Free exploration with blocks provides continuous opportunities for implicit mathematical learning, allowing children to discover concepts of volume, balance, scale, and number independently.

Concrete Numeracy Skill Acquisition

Observational data demonstrated that block construction provides tangible anchors for abstract mathematical concepts:

- 1-to-1 Counting Correspondence: As children build towers or enclosures, they touch and count individual blocks aloud, anchoring verbal number names to physical objects.
- Relative Magnitude Discrimination (More vs. Less): When comparing two block towers (e.g., one built with 6 blocks and another with 7 blocks), children visually gauge height differences. Visual and physical height differences make abstract concepts like "greater than" immediately intuitive.
- Number-Symbol Connection: Guided block tasks significantly accelerated symbol recognition. Observational benchmarks indicated that while only approximately 30% of children could link number symbols to quantities upon entering school, structured manipulative stimulation increased this mastery benchmark to nearly 80%.

"When children physically construct towers of 6 and 7 blocks side-by-side, they do not need to memorize abstract rules. They see and feel the physical height difference, instantly grasping the concept of 'more' and 'less'." — Key Informant Interview

Numeracy Dimension	Observed Manipulative Action
1-to-1 Correspondence	Point-counting individual blocks during assembly.
Magnitude Comparison	Comparing tower heights to determine "more" or "less".
Number-Symbol Alignment	Matching physical block sets to written numeral cards.
Spatial-Logical Reasoning	Balancing block foundations to prevent collapse.

Table 1: Observed Numeracy Behaviors During Block Play

From a neurocognitive perspective, these observations confirm that physical manipulation engages motor, visual, and cognitive brain networks concurrently. The integration of sensory feedback with spatial reasoning strengthens synaptic pathways associated with numerical memory and long-term concept retention.

Holistic Developmental Benefits and Social Scaffolding

Megazos pieces are constructed from high-
Beyond numeracy, block play stimulated multiple developmental domains simultaneously:

- Fine Motor and Spatial Coordination: Balancing blocks requires precise hand-eye coordination, spatial control, and hand muscle strength.
- Executive Function & Problem Solving: Rebuilding collapsed towers fosters frustration tolerance, persistence, and planning.
- Social Interaction and Imitation: Among the 23 observed children,

distinct developmental tiers emerged. While 3–4 children operated at an imitative level (following peers' counting), 1–2 advanced children demonstrated leadership, spontaneously tutoring classmates during building tasks.

Contextual Challenges and Environmental Factors

The study identified key external constraints influencing numeracy development:

- Instructional Monotony Risks: Using blocks continuously without varied challenges leads to interest fatigue. Teachers must combine block tasks with diverse loose-part materials.
- School Attendance and Home Support: Children with frequent absences or limited home learning opportunities showed slower progress in symbol identification, underscoring the critical influence of family engagement.

CONCLUSION

This study confirms that block play serves as an effective, developmentally aligned pedagogical tool for developing early numeracy in children aged 4–5 years. By offering concrete, tactile, and visual experiences, building blocks help young children bridge physical quantities with abstract numerical symbols, master 1-to-1 counting, and comprehend relative magnitudes. To optimize early numeracy, early childhood educators should systematically integrate block construction into core mathematics curricula while maintaining material variety and fostering active home-school partnerships.

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