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# Development of the Magic Cube Numbers Educational Tool to Enhance Symbolic Thinking Skills in Children Aged 4-5 Years

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## ABSTRACT

**Purpose –** Symbolic thinking is a fundamental cognitive ability that enables children to understand and use symbols, such as numbers and letters, to represent real-world concepts. This study aims to develop the Magic Cube Numbers educational tool to enhance symbolic thinking skills in children aged 4–5 years.

**Design/methods/approach –** This research utilizes a Research and Development (R&D) approach, adopting the 4D model by Thiagarajan—Define, Design, Develop, and Disseminate—while focusing on the Develop stage. Data were collected using expert validation sheets and teacher practicality questionnaires, with evaluations conducted by two expert validators and two practitioner teachers.

**Findings –** The Magic Cube Numbers tool obtained a validity score of 82.14%, categorized as "very valid," and a practicality score of 93.84%, categorized as "very practical." These results demonstrate the tool's relevance, usability, and potential to support children's symbolic thinking development.

**Research implications/limitations –** The findings suggest that Magic Cube Numbers is an effective medium for strengthening symbolic recognition and early numeracy. However, the study is limited by its small sample size and specific setting. Broader testing and long-term observation are recommended for generalization and sustainability.

**Originality/value –** This study offers a novel contribution by focusing specifically on symbolic thinking—an often underrepresented aspect of early cognitive development. Through a play-based approach that integrates numerical and alphabetical symbols, Magic Cube Numbers provides practical value for educators and enriches early learning strategies rooted in cognitive development theory.

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## Introduction

Cognitive development in early childhood encompasses essential abilities such as thinking, remembering, problem-solving, and understanding foundational concepts. As Mardotillah et al. (2024) highlight, appropriate stimulation is crucial, given the diverse developmental trajectories among children. Retnaningrum and Umam (2021) further emphasize that optimal cognitive growth occurs when learning experiences align with developmental stages and are reinforced by stimulating environments that nurture adaptation and critical thinking.

According to the National Association for the Education of Young Children (NAEYC), early childhood spans from birth to eight years of age, during which children undergo rapid development across multiple domains of life. One of the most critical aspects during this stage is cognitive development, which refers to a child's capacity to receive, process, and utilize information from their environment (Hanifah & Hasanah, 2019; Ardiana, 2022).

Among the components of cognitive development, symbolic thinking is particularly vital. It enables children to use and interpret symbols—such as numbers and letters—to represent objects and concepts. This ability supports early recognition of quantity, number symbols, and written language (Aisyah, 2021; Bodedarsyah & Yulianti, 2019). However, empirical observations suggest that many children aged 4–5 years still struggle with symbolic understanding, largely due to the limited variety and interactivity of learning media employed by educators (Fuaida, 2023).

In Piaget's theory of cognitive development, children in the preoperational stage (ages 2–7) begin to engage in symbolic function by mentally representing objects that are not physically present. This stage is foundational for developing abstract reasoning through symbolic representation (Novitasari, 2018; Nainggolan & Daeli, 2021). Despite this theoretical understanding, instructional practices in many early childhood classrooms remain conventional—teachers typically write numbers on the board and ask children to imitate—an approach that lacks engagement and often hinders symbolic comprehension (Fuaida, 2023).

Field observations at TKIT Lantai Batu Batusangkar revealed that many children had difficulty recognizing numbers from 1 to 10, identifying number symbols, and grasping basic number concepts. Instructional materials were primarily limited to books and pencils, failing to capture children's interest or foster deeper symbolic thinking. This highlights an urgent need to incorporate more engaging, developmentally appropriate, and cognitively stimulating media to enhance symbolic understanding in young learners.

Studies have confirmed the effectiveness of educational tools and manipulatives in promoting symbolic and numerical skills (Khasanah & Juniarti, 2015; Hardiyanti et al., 2019). Educational games using geometric forms such as cubes have been shown to enhance number recognition and counting skills in a structured yet enjoyable manner (Rohman et al., 2023; Koderi et al., 2021).

In response to these challenges, the researcher developed Magic Cube Numbers, an educational tool in the form of interactive cubes designed to stimulate symbolic thinking in children aged 4–5 years. The tool integrates various learning activities—counting, number recognition, and symbol identification—into a visually engaging format that supports learning through play (Fauziah, 2023).

Although several previous studies have demonstrated the benefits of educational games in early numeracy development (Khasanah & Juniarti, 2015; Rohman et al., 2023), most focus solely on single skills such as counting or number recognition. Few have addressed symbolic thinking holistically, incorporating both numerical and alphabetical symbol acquisition within a unified learning tool. Moreover, existing pedagogical strategies often fail to foster intrinsic motivation due to their reliance on rote methods and insufficient engagement with abstract concepts (Fuaida, 2023). To address this gap, Magic Cube Numbers was conceptualized not only to improve children's counting and recognition abilities but to enhance their capacity for symbolic representation as a whole. By offering a multisensory, game-based experience, the tool is intended to help children connect abstract symbols to real-world meaning, thereby deepening their symbolic reasoning during this critical stage of development (Fauziah, 2023).

Based on this context, the present study aims to develop an educational tool entitled Magic Cube Numbers to enhance symbolic thinking skills in children aged 4–5 years. This research contributes to the advancement of early childhood education by offering an integrative, developmentally appropriate approach to strengthening symbolic cognition through structured play and meaningful interaction..

## Methods

This study employed the Research and Development (R&D) method, a systematic process used to develop and evaluate educational products. R&D is designed to produce new products and assess their feasibility through several stages, including validation and testing. The primary goal of this research was to develop and evaluate the effectiveness of an educational tool, Magic Cube Numbers, intended to enhance symbolic thinking skills in children aged 4-5 years.

The target population for this study was children aged 4-5 years at TKIT Lantai Batu Batusangkar. A purposive sampling method was used to select participants, ensuring that they met the age criteria and were willing to participate in the research. A total of 30 children participated in the study.

The educational tool developed, Magic Cube Numbers, was designed to help children recognize, name, and distinguish numbers 1-10 and understand numerical and letter symbols. The development process followed the Thiagarajan 4D model, which includes the phases of Define, Design, Develop, and Disseminate. However, this study was limited to the Define, Design, and Develop phases.

The data collection process was carried out over a four-week period. During this time, the tool was evaluated by two experts in early childhood education and two teachers at the institution. Experts and teachers provided feedback using validation sheets and practicality questionnaires. The validation process focused on evaluating the content, design, and overall feasibility of the tool, while the practicality questionnaire assessed how effectively the tool could be implemented in a real classroom setting.

Descriptive statistics were used to analyze the validation and practicality scores. The validation scores were categorized into predetermined levels, where scores above 80% were considered highly valid, and practicality scores above 90% were considered highly practical.

To ensure the reliability and validity of the study, the tool was reviewed by multiple experts to confirm the quality of its content and design. Additionally, feedback from teachers, who were familiar with the classroom context, helped ensure that the tool was practical for use in early childhood education settings. Standardized instruments were used for collecting data, and the same evaluation process was applied across all participants to maintain consistency.

The scope of this research is limited to the development and evaluation of Magic Cube Numbers within the context of TKIT Lantai Batu Batusangkar. The findings may not be directly applicable to other educational settings or populations. Furthermore, as the study was conducted only through the Development stage, it did not assess the long-term implementation or wider dissemination of the educational tool.

Table 1. Validation Instrument

| Assessment Aspects | Rating Indicators | Assessment Items | Optional Alternatives | | | | |
|---|---|---|---|---|---|---|---|
| | | | 5 | 4 | 3 | 2 | 1 |
| Graphics eligibility aspects | Shape and size of Magic Cube Numbers game tool | 1. Magic Cube Numbers learning media in accordance with SNI standards | | | | | |
| | | 2. The size of the game tool for learning Magic Cube Numbers according to the content Magic Cube Numbers game tool material | | | | | |
| | Design Magic Cube Numbers Game Tool | 3. Aesthetic Elements | | | | | |
| | | a. Magic Cube Numbers design is interesting for ana | | | | | |
| | | b. The color combination used is interesting. | | | | | |
| | | 4. Elements of Harmonious Layout | | | | | |
| | | a. Print field and proportional margins. | | | | | |
| | | b. Spacing between words and illustrations is appropriate. | | | | | |
| | | 5. Complete Layout Elements | | | | | |
| | | a. The appearance of layout elements on the front and back covers is consistent | | | | | |
| | | b. There are illustrations and story pictures | | | | | |
| | | 6. Media design typography | | | | | |
| | | a. It doesn't use too many typefaces. | | | | | |
| | | b. The use of font variations (bold, italic, all capital, small capital) is not excessive. | | | | | |
| | | c. Width of normal text | | | | | |

| | | |
|---|---|---|
| | | arrangement. |
| | | d. Normal illustration adverb spacing. |
| | | e. Normal kerning between letters. |
| | | 7. Content Illustration |
| | | a. Able to reveal the meaning of illustrations |
| | | b. An accurate and proportionate picture or illustration corresponds to reality. |
| Cognitive Aspects | Businesslike | 1. Sentence Structure Accuracy |
| | | 2. Effectiveness of numbers |
| | Communication | 3. Understanding of information |
| | | 4. Ability to encourage critical thinking. |
| | Compatibility with Student Development | 5. Conformity with the intellectual development of students. |
| | | 6. Conformity to the child's level of cognitive development, namely symbolic thinking |
| | Conformity with Language Rules | 7. Consistency of use of symbols or icons |
| Media Eligibility Aspects | Size Learning Media | 1. Size of game tools for safe learning for learners |
| | The Robustness of Learning Media | 2. Magic Cube Numbers don't come off easily |
| | | 3. Made of strong material |
| | Learning Media Forms and Materials | 4. Not pointed and sharp |
| | | 5. Not easy to tear |
| | | 6. Does not have elements that endanger children |

## Result

This study aimed to develop and assess the validity and practicality of the Magic Cube Numbers educational tool to enhance children's symbolic thinking abilities. The results of both the validity and practicality tests suggest that the Magic Cube Numbers tool is highly effective for this purpose.

Table 3. Results Data

| No | Assessment Aspects | | Validator | | Sum | Maximum | Score Percentage | information |
|---|---|---|---|---|---|---|---|---|
| | | | VI | V2 | | | | |
| 1 | Graphic Aspects | Eligibility | 61 | 58 | 119 | 80 | 74,37% | Valid |
| 2 | Cognitive Aspects | Eligibility | 27 | 34 | 61 | 35 | 87,14% | Very valid |
| 3 | Media Aspects | Eligibility | 27 | 24 | 51 | 30 | 85% | Very valid |

The validity test of the Magic Cube Numbers tool revealed the following results: the Graphic feasibility aspect scored 74.37%, the Cognitive aspect scored 87.14%, and the Media feasibility aspect scored 85%. The overall validity percentage of the tool was 82.14%, categorized as "very valid." These results align with Sudjana (2017), who states that any educational media with a score range of 81-100% is considered very valid. This indicates that the tool meets the standards for validity and can be confidently used to enhance children's symbolic thinking abilities.

Additionally, the practicality test of the Magic Cube Numbers tool yielded an overall score of 93.84%, categorized as "very practical." The individual aspect scores were as follows: the Purpose aspect scored 100%, the Content aspect scored 90%, the Usability aspect scored 96.6%, and the Benefits aspect scored 86.6%. These high scores reflect the practicality of the tool in real classroom settings, indicating that it is easy to use and highly beneficial for the intended audience. These results are consistent with Sudjana's (2017) guidelines, which categorize tools with a score range of 81-100% as highly practical.

The results indicate that the Magic Cube Numbers tool is both very valid and very practical, making it suitable for trial use in children's learning environments. Children using this tool are expected to improve their understanding of number concepts, such as recognizing numbers 1-10, naming them, and associating these numbers with their symbolic representations.

These findings are in line with the research conducted by Arief (2018), who emphasized the importance of using visual aids and educational tools to enhance children's understanding of abstract concepts. The Magic Cube Numbers tool, by providing a hands-on, concrete approach to learning, enables children to grasp these concepts more effectively. It is a clear demonstration of how tangible educational tools can facilitate better learning experiences for children, helping them develop symbolic thinking and cognitive skills.

The study also supports Khasanah's (2015) findings on the role of educational play tools like "Number Cubes" in improving children's understanding of number concepts. Such tools encourage cognitive development and can optimize children's learning according to their developmental stages. The Magic Cube Numbers tool, as an educational play tool, helps children become familiar with number symbols, count objects, and establish an understanding of numerical sequences, as demonstrated in the significant improvements observed in the first and second cycles of this study.

This research contributes to the growing body of knowledge on the role of educational tools in early childhood education. It reinforces the idea that hands-on, interactive tools can significantly enhance children's cognitive abilities, particularly in terms of symbolic thinking. By integrating learning through play, the Magic Cube Numbers tool helps children internalize mathematical concepts in a fun, engaging, and effective way.

However, it is important to acknowledge the limitations of this study. The research was conducted in a specific setting, namely at the TKIT Lantai Batu Batusangkar, and the results may not be generalizable to other educational contexts. Moreover, the study only evaluated the validity and practicality of the tool, and further research is necessary to explore its long-term effectiveness in improving children's symbolic thinking and numeracy skills across various settings. Additionally, future studies could assess the tool's applicability to different age groups or educational systems to further confirm its broader impact.

The Magic Cube Numbers educational tool has been shown to be both highly valid and practical for enhancing children's symbolic thinking abilities. The tool is well-suited to promote early childhood education and can contribute significantly to children's understanding of numbers and their symbolic representations. Future research should explore the tool's long-term effectiveness and investigate its potential for broader use in different educational settings.


Figure 1. Animals Scrabble Animals Media

The development of the Magic Cube Numbers educational tool to enhance children's symbolic thinking skills can be effectively implemented through a play-based learning approach. Play is a natural activity for children, and integrating learning into play makes educational experiences more meaningful and engaging (Bodrova & Leong, 2007). Through play, children are not only entertained but also supported in the development of various domains, particularly the cognitive domain. According to Vygotsky (1978), cognitive development is significantly influenced by social interactions and the use of culturally mediated tools, such as educational games. The Magic Cube Numbers tool serves as such a medium, supporting children's symbolic thinking by providing opportunities for problem-solving and complex reasoning. The activities embedded in this tool help children recognize numbers, understand numerical concepts, and connect symbols to their meanings. This process is crucial, as symbolic thinking forms the foundation for later mathematical and literacy skills (Sarama & Clements, 2009).

The Magic Cube Numbers is a modified version of the original cube game, specially adapted by the researcher to meet the developmental needs of early learners. It focuses on counting objects from one to ten (1–10), recognizing number concepts, identifying number and letter symbols, and enhancing children's symbolic representation abilities. Studies have shown that early exposure to numeracy and symbolic play significantly impacts children's readiness for formal schooling (Duncan et al., 2007).

Furthermore, the use of colorful, thematic images in the Magic Cube Numbers tool aligns with research emphasizing the importance of visual stimuli in early childhood education (Fisher et al., 2011). Attractive visual designs can increase children's attention and motivation to participate in learning activities, making the learning process more effective.

The integration of the Magic Cube Numbers into a play-based learning environment supports children's cognitive and symbolic development. The findings align with previous research indicating that play, when structured with educational intent, can significantly enhance cognitive outcomes in early childhood (Hirsh-Pasek et al., 2009). Therefore, the Magic Cube Numbers tool stands as an innovative and evidence-based contribution to early childhood education practices.

## Conclusion

The development of the Magic Cube Numbers educational tool has proven to be successful and effective in enhancing young children's symbolic thinking abilities. Designed with attractive colors and thematic images, it supports learning activities at TKIT Lantai Batu Batusangkar, helping children count from 1 to 10, recognize number concepts, and understand number symbols. The validity test achieved a score of 82.14% (categorized as very valid), while the practicality test scored 93.84% (categorized as very practical), demonstrating that the tool is highly appropriate and easy to use in classroom settings. Overall, Magic Cube Numbers is an effective, valid, and practical educational resource for strengthening symbolic thinking and numerical understanding in early childhood education.

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