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Enhancing Basic Numeracy Skills in Children Aged 5–6 Years Through PAPINKA: An Interactive Learning Medium

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Abstract

This study aimed to enhance the basic numeracy skills of children aged 5–6 years through the implementation of PAPINKA (Papan Pintar Angka), an interactive learning medium designed to support play-based learning. The study was motivated by the low level of children's numeracy achievement during the preliminary observation stage, where only 33% of children reached the categories of Developing as Expected and Very Well Developed. This research employed Classroom Action Research, consisting of two cycles, each involving planning, action, observation, and reflection stages. The participants were 15 children aged 5–6 years, comprising 8 boys and 7 girls enrolled in Group B at UPTD TK Negeri Idhata Peusangan Bireuen. Data were collected using observation sheets to assess children's numeracy development. The findings revealed a substantial improvement in children's numeracy skills, with learning completeness increasing from 33% in the pre-cycle stage to 60% in Cycle I and 87% in Cycle II. The results indicate that PAPINKA effectively supports play-based learning by providing concrete, interactive, and engaging learning experiences that facilitate children's understanding of numerical concepts. The integration of number recognition, counting, quantity comparison, number sequencing, and simple addition activities into a single learning medium increased participation and motivation to learn among children. This study contributes to the development of innovative numeracy instruction in early childhood education by offering a teacher-designed interactive learning medium that promotes meaningful learning experiences and strengthens children's foundational numeracy skills.

Keywords: PAPINKA, basic numeracy skills, play-based learning, early childhood education, interactive learning media

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INTRODUCTION

Early Childhood Education (ECE) plays a crucial role in supporting children's holistic development, including cognitive, social-emotional, language, physical, and motor domains. Among these developmental aspects, cognitive development is particularly important because it provides the foundation for children's future learning experiences. One of the essential cognitive competencies that should be developed during early childhood is numeracy. Numeracy skills enable children to understand numbers, quantities, patterns, and mathematical relationships that are necessary for solving everyday problems and succeeding in formal education (King & Purpura, 2021).

Numeracy development begins during the early years of life and serves as a strong predictor of later academic achievement. According to Sarama and Clements (Sarama & Clements, 2009), children who acquire strong foundational numeracy skills during preschool are more likely to demonstrate higher mathematical achievement in elementary school. Basic numeracy skills include number recognition, counting, comparing quantities, sequencing numbers, and performing simple arithmetic operations. Therefore, providing meaningful numeracy experiences during early childhood is essential for fostering children's cognitive growth and mathematical understanding (Kolzow et al., 2021).

Despite its importance, developing numeracy skills among young children remains a challenge in many early childhood education settings. Preliminary observations conducted at UPTD TK Negeri Idhata Peusangan Bireuen revealed that children's numeracy achievement was still relatively low. Among the 15 children in Group B, only 33% achieved the developmental categories of Developing as Expected (*Berkembang Sesuai Harapan*) and Very Well Developed (*Berkembang Sangat Baik*). The majority of children experienced difficulties in recognizing number symbols, counting objects accurately, comparing quantities, and performing simple addition

activities. These findings indicate the need for innovative instructional strategies that can improve children's engagement and understanding of numerical concepts (Najwa et al., 2023).

One approach that has been widely recommended for early childhood education is play-based learning. Play-based learning emphasizes active participation, exploration, and meaningful experiences that allow children to construct knowledge through direct interaction with their environment. Research has consistently shown that learning through play enhances children's motivation, attention, and cognitive development (Kolzow et al., 2021). Through playful activities, children are able to engage with abstract concepts in a concrete and enjoyable manner, making learning more effective and developmentally appropriate (Marwan et al., 2023).

In addition to play-based learning, the use of interactive learning media has become increasingly important in supporting early childhood numeracy development. Interactive media provide opportunities for children to manipulate objects, receive immediate feedback, and actively participate in learning activities. Previous studies have reported positive effects of educational game tools, manipulative materials, flashcards, counting sticks, and digital applications on children's numeracy achievement (Rahmawati & Yulianti, 2020). Interactive learning environments help transform abstract mathematical concepts into tangible experiences that are easier for children to understand and remember (Bektiarso et al., 2023).

However, existing studies have primarily focused on learning media that support only one or two aspects of numeracy development. Many educational tools are designed specifically for number recognition, counting, or simple arithmetic activities without integrating multiple numeracy competencies within a single learning medium. Furthermore, several studies have emphasized digital learning applications, whereas limited attention

has been given to teacher-designed interactive media that combine educational play, concrete manipulation, and multiple numeracy activities in one instructional resource (Rahma et al., 2024). This limitation highlights a research gap concerning the development and implementation of comprehensive numeracy learning media for young children (Rizki et al., 2022).

The novelty of this study lies in the implementation of PAPINKA (Papan Pintar Angka), a teacher-designed interactive wooden learning board developed to facilitate multiple numeracy competencies through play-based learning activities. Unlike conventional numeracy media, PAPINKA integrates number recognition, counting, quantity comparison, number sequencing, and simple addition within a single educational game tool. The board incorporates colorful visual elements, animal-themed illustrations, movable learning components, and hands-on activities that encourage children's active engagement and exploration. By combining several numeracy skills into one interactive medium, PAPINKA provides a more comprehensive and developmentally appropriate learning experience for children aged 5–6 years.

The design of PAPINKA is also aligned with Piaget's theory of cognitive development, which emphasizes the importance of concrete experiences during the preoperational stage. Children aged 5–6 years learn more effectively when abstract concepts are represented through tangible objects and direct manipulation (Piaget, 2016). In addition, Vygotsky's sociocultural theory highlights the role of interaction and guided participation in children's learning processes (Wiresti & Na'imah, 2020). Through collaborative play activities using PAPINKA, children are encouraged to interact with peers and teachers while developing their understanding of numerical concepts.

Therefore, this study aims to examine the effectiveness of PAPINKA learning media in enhancing the basic numeracy skills of children aged 5–6 years through Classroom

Action Research (Abdullah Al Munim, 2025). Furthermore, this study contributes to the development of innovative numeracy instruction in early childhood education by providing empirical evidence regarding the effectiveness of a teacher-designed interactive learning medium that integrates play-based learning and multiple numeracy competencies within a single educational resource.

METHODS

Research Design

This study employed **Classroom Action Research (CAR)** following the cyclical model developed by Kemmis and McTaggart (Abdullah Al Munim, 2025). CAR is a reflective research approach that enables teachers to improve instructional practices through systematic cycles of planning, action, observation, and reflection (Wong & Yunus, 2020). This method is particularly appropriate for early childhood education because it facilitates continuous improvement based on classroom needs and children's developmental characteristics (Suharsimi, 2013).

The research was conducted in two action cycles. Each cycle consisted of four stages: planning, action, observation, and reflection. The implementation of two cycles was based on the principle of continuous improvement in CAR, which allows researchers to evaluate the effectiveness of an intervention and make necessary modifications before implementing subsequent actions (Wong & Yunus, 2020). The study was concluded after Cycle II because the predetermined success criterion had been achieved.

Research Setting and Participants

The study was conducted at UPTD TK Negeri Idhata Peusangan Bireuen during the 2025/2026 academic year. The participants consisted of 15 children enrolled in Group B, aged between 5 and 6 years, including 8 boys and 7 girls.

The participants were selected based on preliminary observations indicating that many children experienced difficulties in recognizing number symbols, counting objects accurately, comparing quantities, arranging numbers sequentially, and performing simple addition activities. According to Piaget (Langford & Langford, 2018), children aged 5–6 years are in the preoperational stage, where learning is most effective when abstract concepts are presented through concrete and meaningful experiences. Therefore, interventions utilizing manipulative learning media are highly relevant to support children's cognitive development.

PAPINKA Learning Media

The intervention implemented in this study was PAPINKA (Papan Pintar Angka), a teacher-designed interactive wooden learning board developed to facilitate numeracy learning through play-based activities. PAPINKA integrates several numeracy competencies, including number recognition, counting, quantity comparison, number sequencing, and simple addition within a single learning medium.

The design of PAPINKA was informed by the principles of play-based learning and interactive learning environments, which emphasize children's active participation, exploration, and hands-on experiences (Yanti & Rahma, 2020). Previous studies have shown that interactive educational media can improve children's engagement and support the development of foundational mathematical concepts (Sarama & Clements, 2009).



Figure1.

Research Procedure

Cycle I

During the planning stage, lesson plans, observation sheets, learning materials, and PAPINKA learning media were prepared. Learning activities were designed to introduce number symbols, counting, and quantity-matching exercises. During the action stage, children participated in structured play-based numeracy activities using PAPINKA. They identified numbers, counted objects, matched quantities with numerical symbols, and engaged in simple numeracy games. Learning through play has been shown to enhance children's motivation and facilitate meaningful learning experiences.

Observation was conducted simultaneously to document children's participation and numeracy development using observation sheets. The observation process focused on children's achievement of predetermined numeracy indicators. The reflection stage involved evaluating children's performance and identifying areas requiring improvement. The results of Cycle I indicated that although children's numeracy achievement increased, several children still required additional support and guidance when interacting with the learning media.

Cycle II

Based on the reflection results from Cycle I, several modifications were implemented during Cycle II. Learning activities were diversified through group-based

games, individual challenges, and reward-based participation strategies. Additional teacher guidance was also provided to children experiencing difficulties. The implementation of varied and engaging learning activities was intended to maximize children's participation and maintain their motivation throughout the learning process. According to Vygotsky, (Syarif & Hasan, 2025) guided interaction and social engagement play significant roles in supporting children's cognitive development. Therefore, collaborative activities were incorporated to facilitate learning through peer interaction and teacher scaffolding.

Data Collection Instruments

Data were collected using observation sheets designed to assess children's basic numeracy skills. Observation is considered an effective assessment method in early childhood education because it enables researchers to evaluate children's performance in authentic learning situations (Syarif & Hasan, 2025). The assessment indicators focused on five numeracy competencies:

- Recognizing number symbols.
- Counting objects accurately.
- Matching numbers with quantities.
- Arranging numbers in sequence.
- Performing simple addition activities.

Children's achievement was categorized according to the developmental assessment framework commonly used in Indonesian early childhood education (Syarif & Hasan, 2025).

Category	Description
BB	Not Yet Developed
MB	Beginning to Develop
BSH	Developing as Expected
BSB	Very Well Developed

Data Analysis

The collected data were analyzed using descriptive quantitative analysis. Children's achievement in each category was converted into percentages to determine the effectiveness of the

intervention (P.D, 2014) The percentage of achievement was calculated using the following formula:

$$P = \frac{f}{N} \times 100$$

Where:

P = percentage of achievement

f = number of children achieving the indicator

N = total number of participants

The percentages obtained from the pre-cycle, Cycle I, and Cycle II stages were compared to identify improvements in children's numeracy development following the implementation of PAPINKA learning media.

RESULTS AND DISCUSSION

Implementation of PAPINKA Learning Media

PAPINKA (Papan Pintar Angka) was implemented as an interactive learning medium designed to improve children's basic numeracy skills through play-based learning activities. The medium was developed by teachers using wooden materials and designed with colorful animal-themed illustrations to attract children's attention and facilitate active engagement during learning activities. PAPINKA integrates various numeracy competencies, including number recognition, counting, quantity comparison, number sequencing, and simple addition, within a single educational game tool.

The implementation of PAPINKA was conducted through a series of structured learning activities. Initially, children were introduced to number symbols displayed on the board and encouraged to identify and pronounce each number correctly. Subsequently, they participated in counting activities using colorful wooden beads attached to the board. Children then matched quantities with corresponding number symbols, compared groups of objects using the concepts of "more" and "less," arranged numbers sequentially, and solved simple addition problems using movable learning components. These activities allowed children to interact

directly with learning materials and construct mathematical understanding through meaningful experiences.

The use of PAPINKA reflects the principles of play-based learning, which emphasize exploration, active participation, and hands-on experiences as foundations for cognitive development (Rahma & Fatimah, 2020) Through direct manipulation of objects, children were able to transform abstract numerical concepts into concrete experiences that were easier to understand. Similar findings have been reported by Clements and (Sarama & Clements, 2009) who argued that manipulative-based learning activities significantly support young children's mathematical development by facilitating conceptual understanding and problem-solving abilities.

Furthermore, the attractive visual appearance of PAPINKA contributed to children's motivation and engagement throughout the learning process. The colorful design, animal illustrations, and interactive components encouraged children to participate enthusiastically in numeracy activities. Such findings are consistent with previous studies indicating that interactive educational media enhance children's attention, motivation, and learning outcomes.

Pre-Cycle Results

Before the implementation of PAPINKA, preliminary observations were conducted to identify children's initial numeracy abilities. The results are presented in Table 1.

Table 1. Pre-Cycle Results of Children's Basic Numeracy Skills

Category	Number of Children		%
	BSB (Very Developed)	Well Developed	
	2		13%

BSH (Developing as Expected)	3	20%
MB (Beginning to Develop)	5	33%
BB (Not Yet Developed)	5	33%
Total	15	100%

The findings indicate that children's numeracy achievement was relatively low before the intervention. Only five children (33%) achieved the expected developmental levels (BSH and BSB), while ten children (67%) remained in the MB and BB categories. Most children experienced difficulties in recognizing number symbols, counting objects accurately, comparing quantities, and performing simple addition tasks. This condition may be explained by the limited use of interactive and concrete learning media during numeracy instruction. According to Piaget (2016), children aged 5–6 years are in the preoperational stage, during which learning is more effective when abstract concepts are represented through concrete experiences. Therefore, the low achievement observed during the pre-cycle stage highlighted the need for an intervention capable of providing meaningful and developmentally appropriate learning experiences.

Results of Cycle I

Cycle I focused on introducing PAPINKA and familiarizing children with various numeracy activities. Learning activities included number recognition, counting objects, quantity matching, and simple sequencing exercises.

Table 2. Results of Cycle I Children's Basic Numeracy Skills

Category	Number of Children	%
BSB (Very Well Developed)	4	27%
BSH (Developing as Expected)	5	33%

MB (Beginning to Develop)	4	27%
BB (Not Yet Developed)	2	13%
Total	15	100%

The results of Cycle I revealed a substantial improvement in children's numeracy achievement. The percentage of children achieving BSH and BSB increased from 33% in the pre-cycle stage to 60% in Cycle I. This improvement indicates that PAPINKA successfully stimulated children's participation and interest in numeracy learning activities. Classroom observations showed that children demonstrated enthusiasm when interacting with PAPINKA. They actively manipulated the learning materials, participated in counting games, and engaged in discussions with peers and teachers. These findings support the view that interactive learning media encourage active participation and facilitate children's engagement in learning processes (King & Purpura, 2021)

The improvement observed in Cycle I also supports the principles of constructivist learning theory, which suggests that knowledge is actively constructed through interaction with the environment rather than passively received from teachers (Vygotsky, 1987). Through PAPINKA, children were provided with opportunities to explore numerical concepts independently while receiving guidance from teachers when necessary. Despite the improvement, the predetermined success criterion of 80% had not yet been achieved. Several children still required additional assistance in counting objects accurately and solving simple addition tasks. Consequently, modifications were planned for Cycle II.

Reflection of Cycle I

Reflection activities conducted after Cycle I identified several areas requiring improvement. First, some children still needed intensive guidance when manipulating learning components independently. Second, classroom time management needed improvement to

ensure equal participation opportunities for all children. Third, additional game variations were required to maintain children's attention and motivation throughout the learning process.

These findings served as the basis for improving instructional strategies and learning activities implemented during Cycle II.

Results of Cycle II

Based on the reflection results from Cycle I, several modifications were introduced in Cycle II. Learning activities were diversified through collaborative games, individual challenges, and reward-based participation strategies. Additional support was also provided to children experiencing difficulties during previous activities.

Table 3. Results of Cycle II Children's Basic Numeracy Skills

Category	Number of Children	%
BSB (Very Well Developed)	7	47%
BSH (Developing as Expected)	6	40%
MB (Beginning to Develop)	2	13%
BB (Not Yet Developed)	0	0%
Total	15	100%

The results of Cycle II demonstrated a remarkable improvement in children's numeracy achievement. The percentage of children achieving BSH and BSB increased to 87%, exceeding the predetermined success criterion of 80%. Importantly, no children remained in the BB category. Most children were able to recognize number symbols accurately, count objects correctly, compare quantities, arrange numbers sequentially, and perform simple addition tasks independently. These findings suggest that repeated engagement with PAPINKA activities strengthened children's understanding of numerical concepts and improved their

confidence in solving mathematical problems. The significant improvement observed in Cycle II supports previous findings indicating that repeated exposure to interactive learning activities contributes positively to children's cognitive development and mathematical achievement (Kolzow et al., 2021)

Recapitulation of Learning Achievement

Table 4. Recapitulation of Pre-Cycle, Cycle I, and Cycle II Results

Category	Pre-Cycle	Cycle I	Cycle II
BSB	13%	27%	47%
BSH	20%	33%	40%
MB	33%	27%	13%
BB	33%	13%	0%
Completeness	33%	60%	87%

The recapitulation demonstrates a consistent increase in children's numeracy achievement across all stages of the research. Learning completeness improved from 33% during the pre-cycle stage to 60% in Cycle I and reached 87% in Cycle II.

Discussion

The findings of this study demonstrate that PAPINKA effectively enhanced children's basic numeracy skills. The substantial improvement observed across the two action cycles can be attributed to the integration of multiple numeracy competencies within a single interactive learning medium. PAPINKA enabled children to engage simultaneously in number recognition, counting, quantity comparison, sequencing, and simple addition activities, thereby providing comprehensive learning experiences.

From a cognitive development perspective, the effectiveness of PAPINKA can be explained by Piaget's theory of the preoperational stage. Piaget (Langford & Langford, 2018) argued that young children learn most effectively through concrete experiences and direct manipulation of objects. PAPINKA provided children with

opportunities to interact physically with learning materials, allowing abstract numerical concepts to become more meaningful and understandable.

The findings also support Vygotsky's sociocultural theory, which emphasizes the importance of social interaction and guided participation in children's learning processes (Vygotsky, 1987). During PAPINKA activities, children collaborated with peers, received teacher guidance, and engaged in discussions related to numerical concepts. These interactions facilitated the construction of knowledge through scaffolding and collaborative learning experiences (Bodrova & Leong, 2024).

Another important finding concerns the role of play-based learning in promoting children's numeracy development. PAPINKA transformed mathematical activities into enjoyable learning experiences by incorporating educational games, colorful visual elements, and animal-themed illustrations. According to Hirsh-Pasek et al. (Rahma & Fatimah, 2020), playful learning environments foster children's curiosity, engagement, and cognitive development by combining enjoyment with meaningful learning opportunities. Similarly, Zosh et al. (Marwan et al., 2023) reported that play-based learning improves children's attention, persistence, and motivation during educational activities.

The interactive characteristics of PAPINKA also contributed significantly to children's learning engagement. Classroom observations revealed that children demonstrated higher participation rates, longer attention spans, and greater enthusiasm when completing numeracy tasks. These findings are consistent with previous research indicating that interactive educational media facilitate children's active involvement and improve learning outcomes (Sarama & Clements, 2009).

Furthermore, the results align with previous studies examining the effectiveness of educational game tools in early childhood education. Purpura et al. (King & Purpura,

2021) found that structured numeracy interventions involving manipulative materials significantly improve children's mathematical competencies. Likewise, Widodo and Nurhayati (2022) reported that interactive learning media enhance children's numeracy achievement by providing concrete and engaging learning experiences.

However, this study contributes new evidence to the existing literature by demonstrating the effectiveness of a teacher-designed interactive wooden learning board that integrates multiple numeracy competencies within a single educational medium. Unlike many existing numeracy learning tools that focus on isolated mathematical skills, PAPINKA combines various numeracy activities in a comprehensive and developmentally appropriate manner. This integration represents the primary novelty of the present study and highlights the potential of locally developed educational innovations to support children's numeracy development.

Therefore, PAPINKA may serve as an effective alternative learning medium for early childhood educators seeking practical, affordable, and engaging strategies to strengthen children's foundational numeracy skills while maintaining the principles of play-based learning.

CONCLUSION

This study demonstrates that PAPINKA (*Papan Pintar Angka*) is an effective learning medium for enhancing the basic numeracy skills of children aged 5–6 years. The implementation of PAPINKA through play-based learning activities successfully facilitated children's understanding of numerical concepts, including number recognition, counting, quantity comparison, number sequencing, and simple addition. The interactive and hands-on characteristics of the learning medium encouraged active participation, increased learning motivation, and supported meaningful learning experiences for young children.

The findings suggest that integrating multiple numeracy competencies within a single educational game tool can provide more comprehensive learning opportunities compared to conventional numeracy media that focus on isolated skills. The effectiveness of PAPINKA highlights the importance of utilizing concrete and developmentally appropriate learning resources to support children's cognitive development during the early years. These findings are consistent with constructivist perspectives that emphasize active exploration and direct interaction as essential components of children's learning processes. This study contributes to the development of innovative numeracy instruction in early childhood education by providing empirical evidence regarding the effectiveness of a teacher-designed interactive wooden learning medium. The integration of educational play, visual stimulation, and manipulative learning experiences within PAPINKA represents an innovative approach to strengthening children's foundational numeracy skills. Furthermore, the study expands existing literature on play-based learning and interactive educational media by demonstrating how a locally developed learning resource can effectively support numeracy development among preschool children.

Practically, PAPINKA may serve as an alternative learning medium for early childhood educators seeking engaging, affordable, and developmentally appropriate strategies to enhance children's numeracy literacy. Future studies are recommended to examine the effectiveness of PAPINKA in different educational contexts and to explore its potential integration with digital learning technologies to further support early childhood learning outcomes.

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