PENA PAUD Journal
Volume 6 Issue 2 (2025) Pages 202-214
ISSN: 2775-4731 (Online) 2777-1377 (Print)
: https://doi.org/10.33369/jpp.v6i2.44837

Development of Number Board Media for Early Childhood Pre-Mathematics Introduction

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Abstrak
Early numeracy skills are essential for supporting cognitive development in early childhood education. Observations at TK Yapis Ash Siddiq in Central Papua indicated that many children aged 5–6 years continued to have difficulty recognising and understanding numbers. Therefore, this study aimed to describe the conditions of numeracy learning among children at TK Yapis Ash Siddiq, develop a number board learning medium suited to early childhood characteristics, assess its feasibility, and test its effectiveness in improving numeracy skills. This research employed a Research and Development (R&D) approach using the ADDIE model, encompassing analysis, design, development, implementation, and evaluation. A purposive sampling technique was used to select 12 children aged 5-6 years. A one-group pretest-posttest design was used to measure media effectiveness. Validation results from material and media experts yielded feasibility scores of 90% and 95%, categorised as highly feasible. The average numeracy score increased from 1.6 (on a 4-point scale) to 3.1 (on a 4-point scale), with an N-Gain of 0.64 (medium–high category). Observations also showed that children were highly enthusiastic and actively participated during learning. These results indicate that the number board is both feasible and effective as a learning tool for enhancing early numeracy skills in early childhood education.

Keywords: Learning media, numeracy skills, early childhood, number Board.

How to cite this article:
Ulva, U., Debie Susanti, & Irma Yuliantina. (2025). Development of Number Board Media for Early Childhood Pre-Mathematics Introduction. JURNAL PENA PAUD, 6(2), 202–214. https://doi.org/10.33369/jpp.v6i2.44837

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Publish: Universitas Bengkulu
Received 16 September 2025, Accepted 6 November 2025, Published 21 December 2025

PENDAHULUAN

Early Childhood Education (ECE) is widely recognised as the most crucial stage in the educational system, as it provides the foundation for children's holistic development. This period, often referred to as the golden age, is a critical window in which the brain develops rapidly, and neural connections are highly adaptable (Shepley et al., 2022). Any educational stimulus provided at this stage will have a lasting impact on children's growth across multiple domains.

Development during early childhood encompasses not only physical growth but also cognitive, language, social-emotional, moral, and spiritual aspects (Rahman et al., 2022). For this reason, ECE is not merely a place of care but a structured educational intervention designed to

optimise children's potential and prepare them for future academic and social challenges. According to Piaget's theory of cognitive development, children aged 2–7 years are in the preoperational stage, during which they begin to use symbols to represent objects and events but still think concretely, thus requiring hands-on, manipulative, and object-based learning experiences. Therefore, providing meaningful and tangible learning media is essential for stimulating cognitive development, strengthening understanding, and supporting the development of early numeracy concepts.

Among the various developmental areas, numeracy stands out as a fundamental competence. Numeracy involves much more than rote counting; it includes recognising numbers, understanding quantity, performing simple operations, and applying logical reasoning in daily contexts. (Winutan & Nirmala, 2024). Children who acquire these skills early are better prepared to succeed in mathematics and problem-solving in their later years (Nisaq et al., 2025; E. Sari et al., 2022).

Research highlights that early numeracy achievement strongly predicts future academic performance, particularly in mathematics (Mumtaza et al., 2025). This indicates that numeracy skills developed in kindergarten directly contribute to children's readiness for primary education. Therefore, providing engaging and developmentally appropriate numeracy activities becomes an essential responsibility of early childhood educators (Feni Ayu Mutiara Bru Surbakti et al., 2021; L. M. Sari, 2023).

Despite this importance, numeracy learning in many early childhood institutions remains teacher-centred and heavily reliant on worksheets and memorization (Amelia et al., 2022; Maryati et al., 2022). These conventional practices often fail to foster active participation, leaving children as passive learners. As a result, many children show limited understanding of number concepts and display low enthusiasm for learning activities (Fadilah, 2025).

Similar challenges were observed at TK Yapis Ash Siddiq Papua Tengah, where teachers reported difficulties in teaching numeracy effectively. Children often struggled to recognise numbers consistently and showed low levels of engagement and motivation during counting activities. Such conditions highlight the inadequacy of existing approaches and the urgent need for innovative learning strategies adapted to children's developmental characteristics (Daryati, 2025; Mumtaza et al., 2025).

The lack of appropriate learning media further exacerbates the problem, particularly in remote areas such as Central Papua, where teachers face limited resources that hinder access to modern and practical teaching tools. As a result, numeracy instruction often depends on conventional aids that fail to engage children or align with their developmental needs. In contrast, existing literature strongly emphasises the effectiveness of interactive instructional media such as storybooks,

digital applications, manipulative materials, and board games in enhancing children's motivation and understanding of mathematical concepts (Churchill et al., 2016; Yudha et al., 2023). This contrast highlights a clear gap between theory and practice: while research supports the use of engaging, developmentally appropriate media, classroom implementation in remote areas remains constrained by resource limitations.

Manipulative and visual media, in particular, allow children to explore numbers through play, thereby promoting active learning and conceptual clarity. However, most of these media—such as interactive storybooks, digital applications, and other technology-based tools are often unavailable, unaffordable, or culturally irrelevant to schools in remote areas such as Central Papua. Teachers in these regions face infrastructural and economic limitations that hinder the adoption of modern media in classroom practice. This situation highlights a research-practice gap between theoretical recommendations from existing studies and the actual instructional practices implemented by teachers in the field (Darmayanti, 2022; Eka Daryati & Sadiana, 2025). Therefore, there is a pressing need for simple, affordable, and contextually adaptable learning media, such as the number board, to bridge this gap and enhance the equity of early numeracy education.

Addressing this gap requires developing learning media that are simple, affordable, and feasible for teachers to implement. The number board media, designed specifically for young learners, offers a promising alternative. Unlike worksheets, the number board encourages children to actively manipulate numbers and engage in exploratory activities that foster a more profound understanding.

This study aimed to develop and evaluate a number board learning medium to address challenges in numeracy instruction in early childhood education, particularly in the context of TK Yapis Ash Siddiq in Central Papua. The urgency of this study lies in providing evidence-based solutions that directly inform practice in early childhood education. By equipping teachers with validated and engaging instructional tools, this research is expected to enhance both children's numeracy competence and their enthusiasm for learning. In the long run, such innovations can strengthen numeracy readiness, ensuring smoother transitions into primary education and contributing to broader improvements in educational quality.

METODOLOGI

Type Study

This research employed a Research and Development (R&D) design based on the ADDIE model, comprising five systematic stages: Analysis, Design, Development, Implementation, and Evaluation. This model was chosen because it provides a structured framework for producing and validating learning media that are feasible and effective for early childhood education.

Time And Place Study

The study was conducted at TK Yapis Ash Siddiq in Central Papua during the even semester of the 2024/2025 academic year, spanning six months (March–September 2025).

Target Study

The research subjects consisted of 12 children in Group B, aged 5–6 years, selected through purposive sampling. The selection criteria required that children had recognised basic numbers but still experienced difficulties with simple arithmetic. Class teachers served as facilitators during media implementation and also as validators, along with material and media experts.

Technique Data Collection and Development Instrument

Data were collected through observations, teacher interviews, expert validation questionnaires, and children's pretest and posttest results.

The instruments used in this study included:

1. Numeracy Test: This instrument was used during both pretest and posttest to assess the children's basic counting ability. It consisted of 15 items scored on a 1–4 scale, covering four aspects: recognition of numbers, recognition of number symbols, one-to-one correspondence, and basic mathematical operations.
2. Observation Sheet: This instrument consisted of 10 indicators of child engagement, also using a 1–4 scale. The aspects observed were attention, active participation, enthusiasm, persistence, and social interaction.
3. Expert Validation Sheets: These were divided into material and media validation instruments.
    a. The media expert validation assessed physical appearance, safety, durability, usability, and integration.
    b. The material expert validation assessed alignment with child development, curriculum relevance, coverage of mathematics and communication aspects, and usefulness.

Technique Data analysis

The research employed descriptive data analysis to present and interpret results from the validation process, observations, and pretest–posttest scores.

Descriptive analysis was applied to provide an overview of the children's cognitive development levels before and after using the Number Board media. Quantitative data, including validation and test scores, were processed by calculating average values, percentages, and feasibility levels. Descriptive data analysis was used to describe and interpret children's cognitive development before and after using the Number Board media, providing an overview of achievement levels on each indicator.

RESULTS AND DISCUSSION

RESULTS

This research resulted in an interactive traditional learning medium, the Number Board, developed to improve the early numeracy skills of children aged 5–6 years at Yapis Ash Siddiq Kindergarten in Central Papua. This wood-based media features number cards and pictures that children can directly manipulate. To assess its quality and effectiveness, validation by material and media experts was conducted, along with a limited trial in early childhood groups.

1. Analysis Phase Results

The needs analysis indicated that conventional methods, such as lectures, question-and-answer sessions, and the use of number cards and static posters, continued to dominate numeracy instruction at Yapis Ash Siddiq Kindergarten. Children were often passive, easily bored, and had difficulty understanding concrete number concepts. Observations indicated that only approximately 25% of children were actively engaged in numeracy learning, with an average pretest score of 1.6 on a 4-point scale.

This situation highlights a gap between children's needs for concrete, interactive, and fun media and the limited media available at school. Therefore, developing innovative media in the form of a number board is an appropriate solution.

2. Design Phase Results

The product design focused on creating a 50 x 35 cm wooden board with slots for numbers and pictures. Visual elements, such as fruits (bananas, carrots, and potatoes), were used to contextualise the child's life. Bright colors (red, yellow, green) were chosen to attract attention.

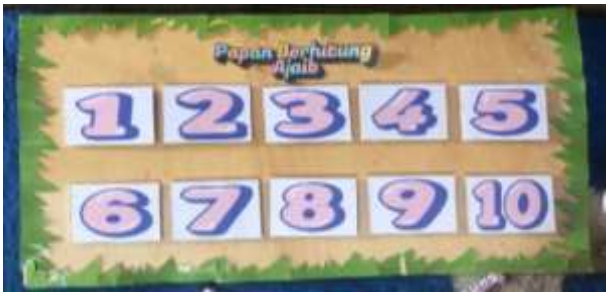

Figure 1. Draft Model

This number board is designed to match the number of objects with their number symbols, practicing one-to-one correspondence, simple addition, and subtraction. Furthermore, this medium supports play-while-learning activities, consistent with principles of early childhood cognitive development.

3. Development Phase Results

Material experts and media experts validated the initial product. The validation results showed scores of 90% (material experts) and 95% (media experts), indicating very suitable

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Figure 2. Draft Model after Revision

After revisions, the product was declared ready for testing.Minor revisions were made, including enlarging the numbers, strengthening the board material for greater durability, and adding a variety of local images to make it more relevant to Papuan children.

4. Results of the Implementation Phase

A limited trial was conducted with 12 children aged 5–6 years. The number board media was used during several arithmetic learning sessions. Children participated in a game in which they matched number cards to the number of pieces on the board.

Observations indicated increased child engagement: 80% of children were more enthusiastic, actively manipulated components, and answered simple arithmetic problems. Teachers also stated that the media was easy to use and practical to integrate with classroom activities.

5. Results of the Evaluation Phase

Effectiveness evaluation was conducted using a one-group pretest–posttest design. The average arithmetic ability score increased from 1.6 (pretest) to 3.1 (posttest), with an N-Gain of 0.64 (medium high). These results indicate a significant improvement in children's beginning arithmetic abilities.

In addition to higher scores, children's participation improved: they were more focused and enthusiastic, and they quickly grasped the concepts of numbers and number symbols. Teachers stated that the number board can be used repeatedly across various learning activities, making it highly practical.

Table 1. Pretest and Posttest Results of Children's Numeracy Ability.

Group	N	Average Pretest	Average Posttest	N-Gain	Category
Experiment (Number Board)	12	1.6	3.1	0.64	Medium-High

Pretest results showed that children's numeracy ability remained low, with a score of 1.6. After using the number board, the average posttest score increased to 3.1, with an N-Gain of 0.64 (medium-high). This improvement indicates that the number board is more effective than the previous method at helping children understand number concepts and simple operations.

Table 2. Results of Validation by Media Experts and Material Experts on the Number Board

Validator	Aspects Assessed	Average Score (%)	Category
Media Expert	Display design, attractive colours, clarity of numbers, and material safety.	95%	Very Appropriate
Material Expert	Content alignment with curriculum, accuracy of number concepts, ease of use	90%	Very Appropriate

The media expert's assessment received a score of 95%, and the material expert's 90%, both of which fall into the outstanding category. Suggestions were limited to technical improvements, such as enlarging the numbers and adding local image variations. This indicates that the number board is valid in both content and appearance and is ready for instructional use.

Table 3. Observation Results of Children's Engagement in Learning Using the Number Board

Observed Aspects	Percentage of Children	Description
Focus while learning	80%	Children concentrate more on following the teacher's instructions and are not easily distracted.
Reading numbers/quantities correctly	75%	Children can recognise numbers and match them to the correct number of objects.
Solving simple arithmetic problems	85%	Children can perform simple addition using a number board.

During implementation, children's engagement increased significantly: 80% were more focused, 75% correctly recognized numbers, and 85% solved simple arithmetic problems. These data support the effectiveness test results, which show that number boards not only improve learning outcomes but also motivate children to participate actively in arithmetic activities.

Descriptive analysis was used to describe and interpret children's cognitive development before and after using the Number Board. This approach was chosen because the research focused on developing and validating suitable learning media rather than testing statistical significance. The descriptive results clearly showed improvements in children's numeracy skills and engagement after the intervention. Although statistical tests, such as normality tests or t-tests, were not performed, the descriptive findings provide strong evidence of practical improvements in learning outcomes. Moreover, integrating Papuan cultural elements such as local fruits, traditional colours, and familiar symbols helped children connect learning materials to their daily experiences. This cultural relevance not only supported better understanding but also strengthened engagement and enthusiasm in numeracy learning activities.

DISCUSSION

The results of this study consistently demonstrate that the use of the Number Board, a modified traditional game-based learning tool, is highly feasible and effective in improving the early numeracy skills of 5-6-year-old children at Yapis Ash Siddiq Kindergarten in Central Papua. The expert-validated product feasibility rate was 90%–95%, and the increase in the average posttest score from 1.6 to 3.1, with an N-Gain of 0.64, confirms the intervention's success. This success can be attributed to the concrete media design, which was developed based on an analysis of children's needs, aligned with the principles of early childhood cognitive development, and enriched with local Papuan cultural elements that make learning more contextual and meaningful.

This finding supports the idea proposed by Wulansari et al. (2025), who emphasised the importance of contextualising mathematical learning media with local wisdom to enhance relevance

and meaning for children in remote areas. In contrast, studies by Misrawati and Suryana (2021) as well as Maulana (2022) Revealed that conventional methods and the lack of culturally contextual learning media often lead to low engagement and limited numeracy progress among early childhood learners. Therefore, integrating Papuan cultural elements into the Number Board distinguishes this study from previous research and demonstrates how culturally grounded learning design can effectively bridge the gap between abstract mathematical concepts and children's real-life experiences.

Significant improvements were recorded in the ability to recognise numbers, match the number of objects, and complete simple addition calculations. These results directly validate the effectiveness of interactive, concrete media in combining elements of play, repetition, and scaffolding. Early childhood children often have difficulty understanding abstract number concepts, but they are highly responsive to concrete and manipulable visual representations. Bruner, 1985; Piaget, 1971). The Number Board provides a clear structure, fosters predictability, and helps children feel a sense of control, making it easier for them to internalise counting skills.

The success of this medium is also closely related to behaviourist principles, as evidenced by its gamification elements. Children's enjoyment in matching numbers to pictures and the sense of accomplishment from solving simple counting problems serve as positive reinforcement, encouraging them to repeat the expected behaviour. This mechanism aligns with behaviourist reinforcement theory, which is effective in increasing motivation and concentration in early childhood learning (Lestari, 2024; Stuhr et al., 2025). By transforming counting activities into a playful challenge, the Number Board turns what was once perceived as a monotonous task into a fun and engaging experience.

Compared with previous research, this study offers an innovative contribution Rohmawati et al. (2023) confirmed that manipulative media can improve numeracy skills, whereas demonstrated that simple teaching aids can enhance understanding of number concepts. However, the Number Board extends these findings by integrating contextual elements of Papuan culture, thereby not only improving cognitive abilities but also strengthening children's local identity. This dual function, academic and cultural, constitutes a novelty that has rarely been explored in prior research.

The integration of local culture within learning activities resonates with the research of Suhermi (2025), who stated that embedding cultural values in learning increases children's engagement and provides more meaningful learning experiences. The findings of this study reinforce

such evidence by demonstrating that culture-based media have great potential as a learning tool for foundational numeracy. Unlike digital media, which require specific technological resources, the Number Board offers flexibility, low cost, and practical usability, making it easily applicable for teachers and parents in traditional classroom settings.

Furthermore, the result of this study supports Setyowahyudi (2020), who found that simple number boards can improve children's numeracy comprehension, although his research did not incorporate cultural aspects. Similarly, a study by Setiani and Limiansih (2023) Confirmed that learning media integrating local culture is more effective in motivating children to learn, even though their research focused on literacy. Compared to these two studies, the Number Board combines both manipulative and contextual advantages, positioning it as a meaningful innovation in early numeracy development.

Rinzani et al. (2023) Found that game-based media with reinforcement principles can improve children's concentration and motivation. This finding aligns with the present study, which found that children displayed high enthusiasm and concentration when engaging with the Number Board. However, the key difference lies in its emphasis on direct physical interaction through number cards and illustrated objects, which not only strengthens cognitive engagement but also stimulates fine motor skills. Therefore, this study extends existing evidence that simple, traditional game-based media can yield learning outcomes comparable to, or even more contextually relevant than, those of digital media (Chandratika, 2025).

In an international review, several studies, such as Churchill et al. (2016)Emphasize the importance of teacher-child interaction and the use of concrete materials to develop both self-regulation and academic skills. The Number Board resonates with these findings but adds a unique local dimension, enabling children not only to learn numbers but also to feel connected to their cultural environment.

Despite its promising outcomes, this study has several limitations. The research was conducted in a single kindergarten with a limited number of participants, which may affect the generalizability of the findings. Moreover, the study focused primarily on short-term outcomes, without longitudinal observation of children’s sustained growth in numeracy. Future research should involve a larger sample across different regions and investigate the long-term effects of the Number Board, including its adaptability in digital or hybrid learning environments.

The implications of these findings are significant for early childhood education (ECE). The Number Board demonstrates that culturally grounded, manipulative, and low-cost media can effectively bridge the gap between abstract numeracy concepts and children’s daily experiences. It

encourages the adoption of contextualised learning tools that not only develop children's mathematical abilities but also nurture their sense of cultural identity and belonging—an essential component in achieving holistic early childhood development.

CONCLUSION

The study concludes that the developed Number Board learning media is highly feasible and effective for enhancing early numeracy skills of 5–6-year-old children at Yapis Ash Siddiq Kindergarten in Central Papua. The integration of local Papuan cultural elements within the media design not only made mathematical concepts more concrete and contextual but also strengthened children's engagement, motivation, and active participation in learning. Compared to conventional methods, the Number Board successfully bridged the gap between abstract numeracy concepts and children's everyday experiences, highlighting the importance of culturally grounded learning tools in early childhood education. Furthermore, the study demonstrates that the media supports holistic development by fostering soft skills such as focus, problem-solving, and collaborative interaction. These findings underscore the potential of innovative, low-cost, and locally adaptable learning media as practical solutions for early childhood education, particularly in resource-limited or remote areas. It is recommended that teachers utilise the Number Board as an alternative numeracy learning medium, and that future research explore its application in other domains, such as literacy or social skills, while continuing to integrate local cultural values to enrich the learning experience.

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