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PAMIN: An Innovative Interactive Magnetic Board to Enhance Alphabet and Counting Skills in 4–5-Year-Old Children

Sarifah Hairani[1*], Yes Matheos Lasarus Malaikosa[2], Ruqoyyah Fitri[3] Andi Kristanto[4], Utari Dewi[5] , Miftakhul Jannah[6]

[1,2,3,4,5,6]*Universitas Negeri Surabaya, Indonesia*

***Corresponding Author**: Sarifah Hairani **E-mail**: Sarifah.hairani13@gmail.com

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ABSTRACT

Alphabet and counting skills are fundamental components in the development of early childhood literacy and numeracy. However, many children aged 4–5 are only able to memorize letters and numbers without understanding their concrete forms and meanings. This study aims to develop and examine the effectiveness of PAMIN (Interactive Magnetic Board) as a learning media to enhance alphabet and counting skills in early childhood. The research employed a Research and Development (R&D) method using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), and was conducted at TK Dharmawanita Tawangsari 2, Sidoarjo. The study involved 23 children in Group A (aged 4–5 years). The instruments used included observation sheets, skill tests, and expert validation questionnaires. The results showed that PAMIN is feasible to use, based on validation by subject matter and media experts. Moreover, there was a significant improvement in both alphabet and counting abilities, with an average N-Gain score of 0.81 (classified as high). PAMIN proved to be effective as it integrates enjoyable multisensory learning through a combination of visual, manipulative, and singing methods. This study concludes that PAMIN is an innovative learning media and is recommended to support interactive learning processes in early childhood education.

Keywords: *Interactive Media, Alphabet, Counting, Literacy and Numeracy, Early Childhood Education*

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INTRODUCTION

Early Childhood Education (ECE) is a crucial phase in establishing the foundation for children's cognitive, social, emotional, language, literacy, and numeracy development (Innes et al., 2023; Putri et al., 2025; Qistina & Khadijah, 2025; Syarfina & Warmansyah, 2025). According to the Indonesian Ministry of Education and Culture Regulation No. 146 of 2014, ECE is defined as an effort to guide children from birth to six years of age through educational stimulation aimed at supporting their physical and psychological growth so they are ready to enter further education (Rachman, 2018). This stage is often referred to as the golden age, during which the child's brain develops rapidly and responds positively to stimulation, including learning media and activities.

The significance of Early Childhood Education (ECE) is inseparable from the crucial role of teachers and education personnel who work directly with young children. In accordance with Law No. 20 of 2003 on the National Education System and the Ministry of Education and Culture Regulation No. 137 of 2014, the academic qualifications and competency standards for ECE educators have been clearly established to ensure the quality of education received by children (Rakhmania et al., 2023; Rizal et al., 2022). ECE teachers, particularly in kindergartens, are required not only to master basic instructional content but also to understand children's psychological development and learning needs (Hapidin et al., 2025; Saleha et al., 2022; Tatminingsih, 2022). Over time, the early childhood curriculum in Indonesia has undergone significant reforms, most notably with the introduction of the Merdeka Curriculum initiated by Nadiem Anwar Makarim, which advocates for a more holistic and child-centered approach that emphasizes children's interests, talents, character development, and foundational skills (Ridwanulloh et al., 2024; Sudaryanto et al., 2020; Warmansyah et al., 2025).

According to the Ministry of Education and Culture Regulation No. 5 of 2022, the Merdeka Curriculum for the Foundation Phase (ages 3–6) emphasizes achievements in literacy and numeracy, particularly pre-mathematical skills, as essential foundations for preparing children for the next level of education (Cahya et al., 2025; D. Lestari et al., 2023; Warmansyah, Yuningsih, Sari, et al., 2023). In the literacy domain, the curriculum aims to develop children's basic skills such as listening, understanding textual messages, recognizing letters and phonemes, and interpreting symbols (Dzata Rahmah et al., 2022; Wiranti et al., 2021). Children are encouraged to read simple words, follow basic instructions, and use language to communicate, collaborate, and express ideas (Sari, 2021). They are also expected to respond to texts both verbally and non-verbally, retell stories, ask questions, and identify story elements such as characters and plot (Chang, 2023; Palinussa et al., 2023). In terms of numeracy, the targeted achievements include pre-mathematical skills that enable children to solve everyday problems using basic mathematical concepts (Machdarini & Hidayat, 2023; Magfiroh et al., 2023). This includes number recognition, simple arithmetic operations (addition, subtraction, equality), counting, object grouping, and the ability to recognize quantities instantly through subitizing.

According to the 2022 PISA report published by the OECD, the literacy and numeracy skills of Indonesian children remain low in comparison to other countries (Mara & Morar, 2023; Soobard & Rannikmäe, 2011; Warmansyah, Yuningsih, Selva Nirwana, et al., 2023). These foundational skills not only encompass mechanical reading and counting, but also include a deep understanding of symbols and the ability to apply them in everyday contexts (Gusmita et al., 2025; McGuire et al., 2012; Rahmawaty & Karwanto, 2021; Wita & Villanueva, 2025). This underlines the importance of strengthening basic competencies from an early age using appropriate pedagogical approache.

However, field observations reveal a gap between curriculum goals and the actual abilities of children. Preliminary observations conducted at TK Dharmawanita Tawangsari 2 in Sidoarjo found that some children aged 4–5 could recite the sequence of letters and numbers through songs, but were unable to recognize the concrete forms of those symbols. For instance, a child could sing the alphabet from A to Z, but was confused when asked to

point to a specific letter or match a number to the corresponding number of objects. This suggests that their learning is based more on memorization than meaningful understanding. This phenomenon aligns with Vygotsky's theory (2021), which asserts that young children require concrete learning experiences and social guidance in order to gradually develop abstract understanding. The tendency of teachers to begin instruction with abstract concepts without providing tangible experiences may contribute to children's weak comprehension of letters and numbers. In this context, it is essential to provide learning media that effectively integrates both concrete and abstract approaches through manipulative, interactive, and enjoyable activities.

Learning media plays a significant role in shaping children's comprehension and learning motivation (Syam et al., 2022; Ulfah et al., 2019). According to Arsyad (2015), instructional media is anything that can be used to convey messages and stimulate thoughts, feelings, attention, and interest in the learning process. Media that is attractive and developmentally appropriate for young children can enhance their learning motivation and support various areas of development, including cognitive and language growth (Bisma et al., 2023; Indrayanti et al., 2024; Norita & Hadiyanto, 2021; Warmansyah et al., 2024). One effective form of media for early learners is manipulative tools such as interactive magnetic boards.

The Interactive Magnetic Board (PAMIN) was developed in response to the need for learning tools that are concrete, visual, kinesthetic, and enjoyable. Inspired by magnetic educational toys such as the Tomindo Magnetic Sketchpad and the Saba Magnetic Drawing Board, PAMIN was adapted into an educational medium that supports letter and number recognition through play and song. This media does not rely solely on physical interaction, such as arranging letters and numbers, but also incorporates singing as a method to enhance memory retention and student engagement. Singing has long been studied as an effective teaching strategy for young children (I. Lestari & Aryanti, 2024). Educational songs that include alphabet and number content have been shown to boost attention, reinforce memory, and create a fun learning environment (Madyawati, 2016; Pertiwi et al., 2022). Children are naturally drawn to rhythm and repetition, making songs a powerful tool for internalizing academic content (Muyassaroh, 2019; Umaroh, 2021). When singing is combined with manipulative tools like PAMIN, a multisensory learning experience is created that aligns with child development principles.

Furthermore, Piaget's (1976) theory of cognitive development emphasizes that children aged 4–5 are in the preoperational stage, where they begin using symbols but still require tangible objects to understand abstract concepts. Therefore, media that allows for direct manipulation such as magnetic letters and numbers is highly effective in helping children comprehend the relationship between symbols and their meanings (Hartati et al., 2014). The principle of learning from concrete to abstract, as advocated in Montessori-based methods, is also highly relevant in the classroom application of PAMIN.

Therefore, this study aims to develop and evaluate the effectiveness of PAMIN (Interactive Magnetic Board) in enhancing the alphabet and counting skills of 4–5-year-old children. This media is expected to bridge the gap between memorization and meaningful understanding, serving as an alternative to formal and abstract learning models. By applying a

play-based approach using engaging media and encouraging active participation, the learning process becomes more meaningful and aligned with the goals of the Merdeka Curriculum at the foundational stage.

RESEARCH METHODOLOGY

Research Design

This study employs a Research and Development (R&D) approach with the primary objective of designing and producing an innovative educational product, specifically the Interactive Magnetic Board (PAMIN) and a complementary singing method. These tools are intended to serve as instructional aids to enhance early childhood literacy and numeracy skills. The development process follows the ADDIE model, which consists of five systematic phases: Analyze, Design, Develop, Implement, and Evaluate. This model, adapted from Branch (2009), offers a structured and effective framework for educational product development. Branch describes ADDIE as "a concept of effective product development that provides a structured process for creating a product."

The application of the ADDIE model in this study is intended to ensure a methodical development process for the PAMIN learning media. Each phase is tailored to the characteristics and needs of early childhood learners. Through this model, the study aims to generate a valid and practical educational product that contributes to improving young children's foundational literacy and numeracy competencies.

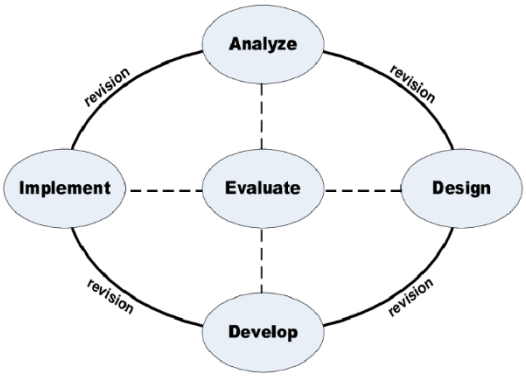


Figure 3.1. The ADDIE Development Model (Source: Branch, 2009)

This study systematically follows all five stages of the ADDIE development model to guide the creation and validation of the PAMIN media and singing method. The researcher carried out the process through to the evaluation phase, including revisions made based on the outcomes of implementation in the field. The stages are outlined as follows: 1) Analysis – Identification of learning needs, target characteristics, and problems faced by early childhood educators in delivering literacy and numeracy instruction; 2) Design – Planning of media content, visual layout, and integration of singing methods with interactive components; 3) Development – Creation of the prototype of the Interactive Magnetic Board and singing modules; 4) Implementation – Field testing of the developed product with selected early childhood learners and teachers; 5) Evaluation – Assessment of product effectiveness and practicality through expert validation, observational data, and feedback from users.

Analyze	Design	Develop	Implement	Evaluate
Identify the probable causes for a performance gap.	Verify the desired performances, and appropriate testing methods.	Generate and validate the learning resources.	Prepare the learning environment and engage the students.	Assess the quality of the instructional products and processes, both before and after implementation.
1. Assess performance 2. Determine instructional goals 3. Analyze learners 4. Audit available resources 5. Determine delivery systems (including cost estimate) 6. Compose a project management plan	7. Conduct a task inventory 8. Compose performance objectives 9. Generate testing strategies 10. Calculate return on investment	11. Generate instructional strategies 12. Select or develop media 13. Develop guides for the student 14. Develop guides for the teacher 15. Conduct formative revisions 16. Conduct a Pilot Test	17. Prepare the teacher 18. Prepare the student	19. Determine evaluation criteria 20. Select evaluation tools 21. Conduct evaluations
Analysis Summary	*Design Brief*	*Learning Resources*	*Implementation Strategy*	*Evaluation Plan*

Figure 3.2. The ADDIE Research and Development Procedure
(Source: (Branch, 2009))

Trial Design

The trial design involves a systematic validation and testing procedure, including expert validation and field testing with children. Media and content experts are engaged to ensure the feasibility and relevance of PAMIN before its implementation in early childhood education settings. The study applies a one-group pretest-posttest design to evaluate the effectiveness of PAMIN. Twenty-three children aged 4–5 years from TK Dharmawanita Tawangsari 2 in Sidoarjo participated in the trial. Pretest data was collected before the media intervention, followed by a posttest to measure any improvements in alphabet and counting abilities.

Figure 1. Design of "PAMIN"

Expert Validation

Media Expert Validation was conducted by Prof. Dr. Andi Kristanto, S.Pd., M.Pd. (Universitas Negeri Surabaya) to assess design feasibility, interactivity, and usability. Content Expert Validation was conducted by Dr. Ruqoyyah Fitri, S.Ag., M.Pd. (Universitas Negeri Surabaya) to evaluate material appropriateness and its alignment with developmental objectives for early childhood. Experts were selected based on the following criteria: 1) Minimum qualification of a Master's degree in Early Childhood Education or Educational Technology; 2) Academic background and teaching experience in media development or early childhood curriculum.

Figure 2. The results of the "PAMIN" media

Types of Data

Qualitative Data: Gathered from expert comments, suggestions, and descriptive feedback used for revising and refining PAMIN. Quantitative Data: Obtained through observation, questionnaires, and pretest-posttest results. Data was statistically analyzed using

SPSS and the normalized gain (N-Gain) formula to determine the magnitude of improvement in children's performance.

Instruments for Data Collection

Validation Sheets: Used to collect expert judgments on various aspects of media quality using Likert scales. Questionnaires: Distributed to teachers and children to measure practicality, interest, and perceived learning benefits. Observation Sheets: Used by teachers to assess children's alphabet and counting skills during the learning process.

Data Analysis Techniques

Feasibility Analysis: Likert scale results from expert validation were converted into percentage values and interpreted using feasibility criteria. Effectiveness Analysis: The N-Gain test was applied to compare pretest and posttest results. The N-Gain score was categorized as High ($g > 0.70$), Medium ($0.30 < g <= 0.70$), or Low ($g < 0.30$) (Sukarelawan et al., 2024). Practicality Analysis: Practicality was measured using percentage-based interpretation from teacher and child questionnaires. Media with a practicality percentage above 76% was considered effective for classroom implementation.

RESULTS AND DISCUSSION

Development Stages of PAMIN Media Using the ADDIE Model

The development of PAMIN (Interactive Magnetic Board) was carried out through a structured process using the ADDIE instructional design model. This section presents research findings from four key phases: Analysis, Design, Development, and Implementation, highlighting how each stage contributed to the development of an effective educational medium for 4–5-year-old children.

Analysis Phase

The analysis phase aimed to identify specific instructional challenges in the areas of early literacy and numeracy. Observations conducted at TK Dharmawanita Tawangsari 2, Sidoarjo revealed that while many children could recite the alphabet and count numbers, they struggled to connect these symbols with their concrete meanings. This indicated a gap between memorization and conceptual understanding.

To address this, a detailed needs analysis was conducted based on developmental psychology principles, particularly Piaget's pre-operational stage, which emphasizes the need for tangible, sensory-based learning. The study also evaluated existing learning materials and found that conventional tools such as worksheets and posters lacked interactivity and engagement. These findings underpinned the conceptualization of PAMIN as an interactive, multisensory media designed to stimulate literacy and numeracy in a developmentally appropriate manner.

Design Phase

During the design phase, the structure and components of PAMIN were systematically developed. The media content was tailored to support the acquisition of alphabetic knowledge and counting skills through engaging and interactive formats. Key elements in this phase included the creation of a storyboard to visualize the instructional sequence and a user manual to guide educators in using the media effectively. The media was designed to incorporate colorful magnetic letters and numbers, visual object associations, and an embedded singing method to aid retention and motivation. Learning indicators were also formulated, and assessment instruments such as expert validation sheets and observation forms were prepared to evaluate media performance in classroom settings. The design prioritized child safety, ergonomics, and visual appeal.

Development Phase

The development phase involved translating the design plan into a physical learning tool. The PAMIN prototype was constructed using magnetic boards, EVA foam letters and numbers, and images curated from educational visual resources. These components were selected for their child-friendliness, durability, and manipulability. Initial testing was conducted through a formative evaluation involving a small sample of children. Feedback gathered during this stage was used to refine the prototype. Improvements included enhancing color contrast, adjusting the size of magnetic pieces for better grip, and adding instructional visuals. The product was then finalized with improved features that supported tactile, visual, and auditory learning experiences. These enhancements ensured that PAMIN was both educationally effective and appealing to its young users.

Implementation Phase

The implementation phase tested the applicability of PAMIN in an authentic classroom environment. The media was introduced to 23 children in Group A at TK Dharmawanita Tawangsari 2. Teachers were first trained on how to utilize PAMIN within daily learning routines, ensuring consistent and effective usage. In-class activities included letter identification, number matching, and singing exercises using the media components. Observations during implementation showed that children demonstrated high levels of engagement, increased focus, and improved interaction with learning tasks. The multisensory nature of PAMIN made learning more accessible and enjoyable, reinforcing conceptual understanding through hands-on experiences.

Teacher feedback highlighted the practicality, attractiveness, and instructional value of the media. PAMIN was recognized as a supportive tool for differentiated instruction and classroom management. This stage confirmed the media's effectiveness in fostering foundational literacy and numeracy skills, as well as promoting an active and enthusiastic learning environment.

Evaluation Phase

The implementation was conducted at TK Dharmawanita Tawangsari 2, Sidoarjo, involving 23 children from Group A. The study followed the ADDIE development model

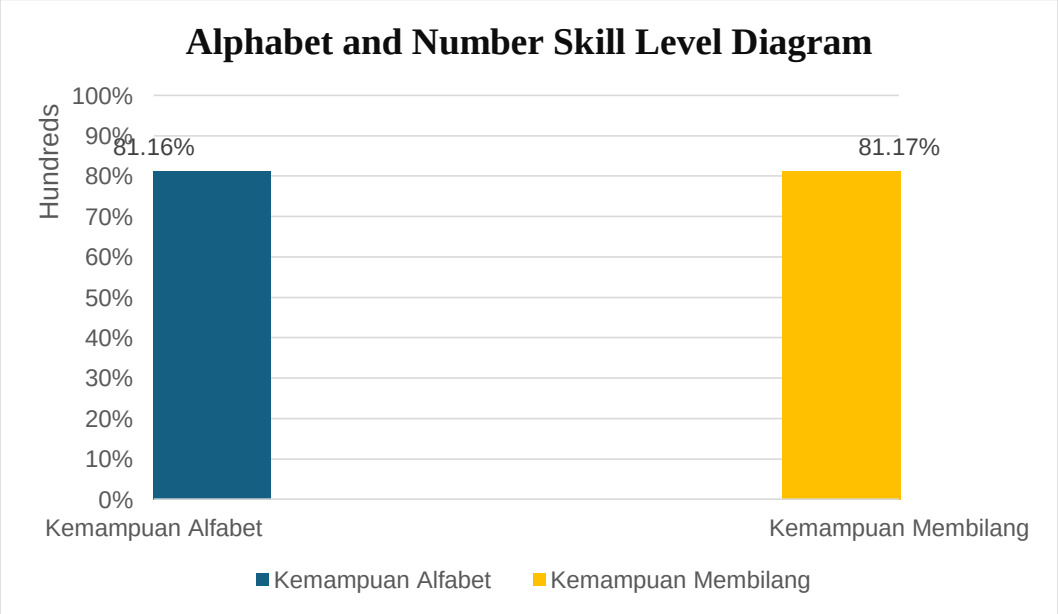
and focused on media effectiveness by analyzing pretest and posttest data using the N-Gain formula.

Instrument Validity and Reliability

The instruments used to assess alphabet and counting skills underwent validity and reliability testing. All 16 items in the alphabet test and 18 items in the counting test were declared valid, with calculated r-values exceeding the r-table and significance levels below 0.05. Reliability tests yielded Cronbach's Alpha values above 0.70: 0.774 (alphabet pretest), 0.776 (alphabet posttest), 0.770 (counting pretest), and 0.774 (counting posttest), indicating that the instruments used were reliable.

N-Gain Results for Alphabet Skills and N-Gain Results for Counting Skills

The average N-Gain score for alphabet skills was 0.81 or 81.16%, categorized as high and effective. All children showed significant improvement from pretest to posttest. For instance, subject AQ improved from a score of 27 to 89 (N-Gain 0.85), while subject DL improved from 20 to 89 (N-Gain 0.86). Counting skills also demonstrated significant improvement. The average N-Gain score was 0.81 or 81.17%, confirming that PAMIN was highly effective. Improvement was consistent across all children, who initially struggled to connect numerical symbols with actual quantities. These findings indicate that both alphabet and counting skills improved significantly with the use of PAMIN, with average N-Gain scores at 0.81 for both areas, falling into the high effectiveness category.



Discussion

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The implementation phase tested the applicability of PAMIN in an authentic classroom environment. The media was introduced to 23 children in Group A at TK Dharmawanita Tawangsari 2. Teachers were first trained on how to utilize PAMIN within daily learning routines, ensuring consistent and effective usage. In-class activities included letter identification, number matching, and singing exercises using the media components. Observations during implementation showed that children demonstrated high levels of engagement, increased focus, and improved interaction with learning tasks. The multisensory nature of PAMIN made learning more accessible and enjoyable, reinforcing conceptual understanding through hands-on experiences. Teacher feedback highlighted the practicality,

attractiveness, and instructional value of the media. PAMIN was recognized as a supportive tool for differentiated instruction and classroom management. This stage confirmed the media's effectiveness in fostering foundational literacy and numeracy skills, as well as promoting an active and enthusiastic learning environment.

The results of this study are strongly supported by recent research on early childhood learning strategies. Bisma et al. (2023) found that the use of audio storytelling significantly improves children's attention and digital literacy, especially when combined with interactive visual content. Lestari and Aryanti (2024) also emphasized the effectiveness of singing methods in building early literacy and character development, aligning well with the musical component integrated into PAMIN. Chang (2023) underlined the long-term academic benefits of early literacy and numeracy exposure, suggesting that engaging children with foundational skills through practical media like PAMIN contributes positively to their academic trajectory. Innes et al. (2023) demonstrated that manipulative-based tools such as origami promote not only fine motor development but also cognitive flexibility in young learners. Similarly, Gusmita et al. (2025) stressed the importance of movement-based memorization for improving learning retention, which reinforces the physical and musical interactivity designed into PAMIN. These findings are also in line with Branch (2009), who argued that instructional media developed through structured models like ADDIE can result in educational tools that are pedagogically sound and learner-centered.

Altogether, the findings from this study and the supporting literature confirm that the PAMIN media effectively integrates theoretical and practical approaches in early childhood education. Its emphasis on multisensory learning, developmental appropriateness, and playful instruction contributes meaningfully to the development of literacy and numeracy skills in young children, aligning with both national curriculum goals and global pedagogical standards.

CONCLUSION

The development of PAMIN (Interactive Magnetic Board) has demonstrated strong potential as an effective instructional medium to support the acquisition of alphabet and counting skills in early childhood education. Its design, which integrates multisensory elements visual, auditory, and kinesthetic—proves to be developmentally appropriate and pedagogically sound for learners aged 4–5 years. By providing a tangible and interactive experience, PAMIN facilitates children's ability to connect abstract symbols with concrete meanings, thus fostering deeper conceptual understanding in both literacy and numeracy.

Moreover, expert validation affirms the media's relevance, usability, and alignment with the learning needs of early learners and curricular demands. The implementation of PAMIN also contributes to more dynamic classroom interactions and fosters child engagement, which are central to the goals outlined in the Merdeka Curriculum for the foundational phase. As a result, PAMIN is well-positioned to serve as a practical and innovative tool in early childhood education. Future enhancements may include the integration of digital components and expanded content areas to further enrich the learning experience and adapt to evolving educational contexts.

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