Jurnal Manajemen Pendidikan *Volume 14, No. 02, 2026, Halaman 1054 – 1059*
https://jmp-pasca.unpak.ac.id/index.php/jmp *e-SSN: 2614-3313 ; p-ISSN: 2302-0296*
Penerbit: Sekolah Pascasarjana, Universitas Pakuan

A SYSTEMATIC LITERATURE REVIEW ON INNOVATIVE APPROACHES IN EARLY NUMERACY EDUCATION: THE CASE OF SMART DAKON GAME MODIFICATION

Unshita Rini [a*)], Yulianti Fitriani [b)], Erie Siti Syarah [a)]

[a)] *Universitas Terbuka, Jakarta, Indonesia*
[b)] *Universitas Pendidikan Indonesia, Serang, Indonesia*

[*)]*e-mail korespondensi: unshita.rini88@gmail.com*

Article history: received 06 Mei 2026; revised 20 Mei 2026; accepted 06 June 2026 *DOI : https://doi.org/10.33751/jmp.v14i02.261*

Abstract. Numeracy problems in childhood are a critical issue that can significantly impact children's academic success in the future. Many children as young as three years old show difficulty in understanding basic numerical concepts. So, engaging media is needed to facilitate children's understanding of numeracy. The modification of the Dapin game is a medium that can be used to identify early numeracy and analyze the effectiveness of the Dapin game modification in improving early numeracy in children. This systematic review was conducted using the PRISMA model with databases of articles from Scopus, Google Scholar, and PubMed from 2014 to 2024. The main results of this study show that children's ability to count in the correct order, one-to-one correspondence, and cardinality using Dapin significantly improved, while modified Dapin games were very effective in helping children enhance their early numeracy. By using Dapin, in addition to stimulating early numeracy in children, they also become accustomed to communicating using polite words, sharing, cooperating, developing fine motor skills, being responsible, and becoming familiar with traditional games.

Keywords: Early numeracy, Early Mathematical Abilities, Math Skills, Traditional Game.

I. INTRODUCTION

Numeracy problems in childhood are a critical issue that can significantly impact children's academic success in the future. (Lopez-Pedersen dkk, 2023). Many children as young as three years old show difficulty in understanding basic numeric concepts. (Fahlevi, 2024). Research shows that many children struggle with basic numeracy skills, which can lead to long-term difficulties in mathematics. (Chen, 2024).

In the context of early mathematics education, there are several issues faced by educators and parents. (Petropoulou dkk, 2024). Such as the lack of interest in children towards learning mathematics, which is often considered difficult and boring (Palmér & Bommel, 2018). On the other hand, children struggle to understand basic mathematical concepts, which can hinder their development in the future. (Bowie, 2024).

Early numeracy skills are crucial for lifelong mathematical achievement, with symbolic numeracy emerging as children learn number words and counting concepts (Chen, 2024), which can form the foundation for more complex mathematical concepts (Lopez-Pedersen et al., 2023; Fahlevi, 2024) to build a strong mathematical foundation, which is linked to future academic success. (Onoshakpokaiye, 2023). This is in line with Kindergarten programs aimed at improving children's number understanding, which have shown moderate to strong impacts on children's math achievement, indicating that early intervention is very important (Fahlevi, 2024).

Children who have good mathematical abilities from an early age tend to have better academic achievements later on. (Simatupang et.al., 2023; Iswi et al., 2024). According to Träff et al. (2023), good numerical ability in early childhood is not only related to higher mathematical skills but also to better problem-solving abilities. Therefore, educators and parents need to pay attention to and stimulate children's numeracy (Palmér & Bommel, 2018) through play and everyday experiences, especially in terms of counting, arithmetic, and geometry (Palmér & Bommel, 2018).

A study involving ninety children aged four to six years found that older children performed better on math tasks than younger children. (Al-Hrout, 2023). Statistics show that around 60% of preschool-aged children in various countries still struggle to understand basic mathematical concepts (Träff et al., 2023). This indicates the need for appropriate interventions to enhance children's early mathematical abilities. (Korat et al., 2017). Therefore, introducing engaging, interactive learning methods, such as games, can be an effective solution. (Fadilah et al., 2024). Games not only improve math skills but also make learning more enjoyable for children. (Mulyani et.al., 2020).

Observation of development activities at TK Puspa Melati revealed a problem with low numeracy mastery related to estimating the sequence of numbers 1-10 among children in group A2, which consists of 18 children, marked by the following conditions: First, 4 children (22%) could correctly sequence the numbers 1-10. Second, 5 children (27%) could recite the sequence of numbers 1-10. Third, 9 children (50%) could neither sequence nor recite the numbers 1-10 correctly. After going through a process of thinking/reflection, the author concluded that the selection of media in the early mathematics learning process related to estimating the sequence of numbers 1-10 needs to be improved.

Based on that background, the author attempts to offer a modified Dakon game called DAPIN (Dakon Pintar) to facilitate students in mastering early numeracy related to estimating the sequence of numbers 1-10. The advantage of DAPIN is that children are trained to recite the order of numbers while playing DAPIN, as they must state the sequence of numbers each time they drop the DAPIN knob/button. They can arrange the numbers 1-10 because, at the end of the game, each team must arrange the numbers 1-10 until the DAPIN knobs/buttons are exhausted. Another impact is that the number of players has been modified to 5 people, stimulating children to be trained in communicating with other children; the limitation on the number of buttons to be sorted stimulates children to empathize and help each other. The hope is that the modification of the DAPIN (Dakon Pintar) game can help introduce and teach numeracy to young children.

Literature studies show that most research on the Dakon game focuses on numeracy in early childhood, but there are no modifications, innovations, or effectiveness of the Dakon game to improve children's numeracy. There has not yet been a comprehensive study that integrates a literature review and practical guidelines to optimize the Dakon game in the context of early childhood education.

Thus, this research offers a new approach by identifying and analyzing the latest innovations in the modified Dakon game for the implementation of numeracy in early childhood education. This offer includes the Modification of the DAPIN Game (Smart Dakon) for Early Childhood Numeracy as its novelty.

II. METHOD

This research uses a systematic literature review method to relate early numeracy, early mathematics abilities, mathematics skills, traditional games, and modified Dakon games in early childhood. This systematic approach allows researchers to collect and analyze data from various sources in a structured and standardized manner. According to Balladares (2024), systematic literature reviews are an effective methodology for identifying, evaluating, and synthesizing relevant research in a particular field. The main focus of this research is how modifications to the DAPIN (Dakon Pintar) game can improve early mathematics abilities in young children.

A. Inclusion and Exclusion Criteria of Literature

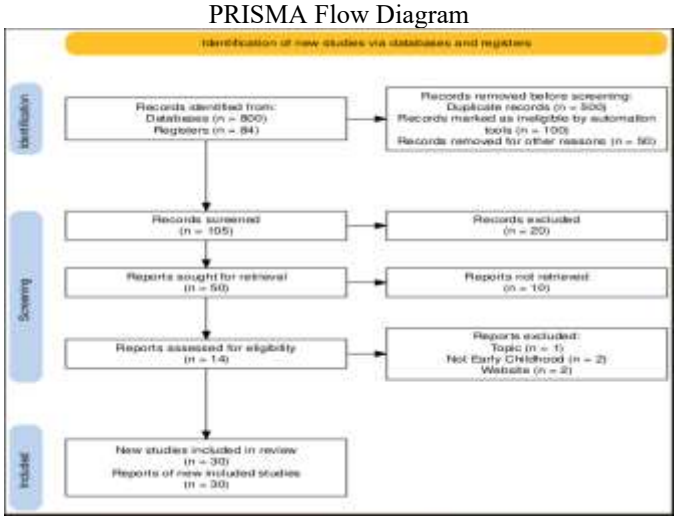
Inclusion and exclusion criteria are essential in systematic literature reviews to ensure that only relevant and high-quality studies are included in the analysis. The following table shows these criteria:

Table 2.1
Inclusion and Exclusion Criteria of Literature

Aspects	Inclusion Criteria	Exclusion Criteria
Type of Study	Peer-reviewed journal articles. Quantitative, qualitative, or mixed studies Relevant literature reviews or meta-analyses.	Non-peer-reviewed articles (opinions, editorials, informal reports). Theory-based studies without empirical data or implementation evaluation.
Research Topics	Discussing initial mathematical abilities. Using the Dakon Smart Game Modification. Evaluating the effectiveness of using the Dakon Smart Game Modification	Not discussing initial mathematical abilities. Using the Dakon Smart Game Modification. Evaluating the effectiveness of using the Dakon Smart Game Modification
Population	Early childhood (3–7 years).	Not focusing on early childhood or covering a wide age group without separate data for early childhood.
Language	Articles in English or Indonesian.	Articles published in languages other than English or Indonesian.
Publication Period	Articles published in the last 10 years (2014-2024)	Articles published more than 10 years ago (unless considered seminal).
Research Results	Reporting empirical results related to improving early mathematics abilities	Studies with no empirical results or only highlighting clinical interventions without educational elements.
Accessibility	- Articles with full-text access (open or through institutions).	- Articles with full text that are not accessible.

The collection process used in this study is Publish or Perish, with a focus on the Scopus database. The data processing tool used is PRISMA, with the following results:

Chart 2.2
PRISMA Flow Diagram



III. RESULT AND DISCUSSION

Jean Piaget emphasized the importance of cognitive development in understanding mathematical abilities, particularly through sensorimotor interactions with the world around us (Araújo Hoyos, 2017). The sensorimotor stage and numerical understanding Piaget considers the sensorimotor stage, which occurs between infancy and two years of age, to be crucial for developing basic numerical concepts. (Parviainen, 2019). At this stage, children learn directly from the world around them, which forms the foundation for their mathematical abilities later on. (Hulme, 2019). The predictive nature of early numerical abilities can forecast a person's future mathematical abilities, indicating that early mathematical skills can influence how they learn mathematics in the future (Supply et al., 2020).

Piaget describes the sensorimotor stage and numerical understanding stage, which consists of the period from birth to two years, and is referred to as the Sensorimotor Stage. (Sidik, 2020). Similarly, with cognitive profiles and variability, children with different cognitive profiles can show variations in early numerical skills. (Hulme, 2019). This includes children with Turner syndrome, which highlights the complexity of early mathematical ability development. (Supply et.al., 2022). Children at this age are in the pre-operational stage, where they begin to understand symbols and basic concepts, but still struggle with logical thinking (Träff et al., 2023).

This variation highlights the importance of understanding individual differences in cognitive development when assessing early mathematical abilities, such as number recognition, counting, and basic arithmetic, which are the foundation for advanced mathematical competence (Parviainen, 2019). Understanding the relationship between geometry and spatial concepts is crucial for mathematical reasoning and problem-solving (Araújo Hoyos, 2017). Logical operations and the ability to apply mathematical concepts in various contexts arise as a result of active interaction with our environment (Parviainen, 2019).

In Vygotsky's perspective, mathematics education is crucial for building a strong foundation that can influence future academic success (Onoshakpokaiye, 2023). Engaging children in games and creative problem-solving in mathematics can enhance their confidence and critical thinking skills. (Onoshakpokaiye, 2023).

Cognitive development theory, as proposed by Vygotsky, emphasizes the importance of social interaction in children's learning, where peers or more knowledgeable adults can help someone understand something (Onoshakpokaiye, 2023; Fadilah et.al., 2024). By maximizing the Zone of Proximal Development (ZPD), children will receive appropriate guidance, achieve a higher level of understanding, which impacts their early mathematical abilities where peers or more knowledgeable adults can help someone understand something (Yuliana et.al., 2022).

Both Piaget's and Vygotsky's theories emphasize the importance of social interaction and cognitive development in mathematics learning. Piaget's theory emphasizes that the stages of a child's cognitive development affect their understanding of mathematics, while Vygotsky's theory emphasizes that collaborative learning and social context are crucial for the formation of early mathematical abilities.

Basic mathematical concepts that need to be taught to young children include the introduction of numbers, addition, subtraction, and understanding patterns (Cezarotto, 2024). Research shows that introducing these concepts early can help children build a strong foundation for future mathematics learning. (Ratna Dewi et.al., 2021). According to Parviainen et al. (2022), "Early mathematical abilities are very important because they serve as the foundation for more complex mathematical understanding later on." Research shows that children who have good early mathematical abilities tend to be more successful in learning mathematics at higher levels. (Galeano, 2024).

Early mathematical ability significantly affects critical thinking skills. Students with high initial abilities master all indicators of critical thinking, while students with moderate and low initial abilities face difficulties in solving trigonometry problems. (Harahap et.al., 2024). Studies tracking students from preschool to subsequent grades show that their early math competencies correlate with their later academic achievements. (MacDonald & Carmichael, 2018).

In conclusion, early mathematical abilities emphasize the importance of students' learning outcomes and their problem-solving skills in various educational contexts. Studies have consistently shown that students' basic math skills can predict their performance in subsequent math tasks and interventions. This relationship highlights the importance of enhancing initial abilities to improve educational strategies.

Early literacy and numeracy, which develop from a young age, are very important for future academic success. Children demonstrate basic abilities to think logically, creatively, and collaboratively. Children have the ability to recognize and understand relationships between patterns, symbols, and data, and they can use these abilities to solve everyday problems (Saku, 2021).

Numeracy skills in early childhood are also related to basic problem-solving abilities and the application of mathematics in daily life, not just counting skills, but also include algebraic thinking, geometry, measurement, data analysis, and probability. Knowledge, skills, behaviors, and tendencies are needed for someone to be able to use mathematics in various situations. Early numeracy refers to the fundamentals of mathematical reasoning acquired at a young age. (Saku, 2021).

Content	Ages 5-6 Years
Algebra	sorting, grouping, creating patterns, solving problems
Numbers	comparing, ordering (first, second, and third), sharing materials among friends, counting, one-to-one correspondence
Geometry	geometry is more than just naming geometric shapes, including understanding spatial relationships, position, 2D and 3D objects
Measurement	understanding the attributes of objects, building the concept of non-standard measurement, applying numbers to measure, and seriation
Data Analysis	collecting information, organizing information simply, asking and answering questions related to the information collected, with organization

IV. CONCLUSION

An effective learning method for early childhood is one that is interactive and enjoyable. (Nofriyanti & Sari, 2019). Through play, children can learn while playing, which can enhance their motivation and engagement in the learning process. (Eti Nurhayati et.al., 2022). According to Mulyani et al. (2020), "educational games can enhance children's cognitive, social, and emotional skills." In the context of modification, dakon can be designed to introduce various mathematical concepts, such as sorting patterns, making estimations, operational numbers (addition, subtraction), and geometry. (Ratna Dewi et.al., 2021). For example, by using different quantities of seeds, children can be taught to count the total number of seeds present, as well as perform basic mathematical operations. This is in line with research that shows that number-based games can enhance counting skills and understanding of mathematical concepts in children. (Fadilah et.al., 2024). This Dapin is inspired by the modified congklak/dakon game. Has 10 small granaries and 2 large granaries/home granaries. Each small barn contains 5 buttons/flat buttons. Dapin is played by five people, consisting of 2 groups and 1 player as the banker. The first equipment of this game is 12 Dapin barns consisting of 10 small barns facing each other and 2 large barns at both ends. The two Dapin seeds consist of 50 flat buttons (10 bins x 5 flat buttons). Dapin seeds are flat and round in shape, with numbers on one side and letters on the other. The three picture cards function to match the number of objects in the picture with the corresponding number. By modifying the number of barns, dapin seeds, number of players, and game rules, it is hoped that children can become more engaged and gain a better learning experience. (Mulyani dkk., 2020). The positive impacts/advantages of DAPIN from educational games on children's learning are: 1) Mastery of number concepts, including stating number symbols in order (estimation), grouping the same numbers, and linking images with corresponding numbers more quickly because each time players distribute buttons in the small barn, they are required to state the sequence of numbers and arrange them when all the barns are empty. 2) Mastery of numbers, stating the required numbers, and making number sequences better. 3) Coordination between eyes and hands is increasingly trained. 4) Ability to make decisions accurately. 5) Patience in waiting for turns. 6) Willingness to play and appreciate friends. 7) More intense communication with friends. 8) Empathy. 9) DAPIN is contextual learning.

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