The Effect of Media Mix and Match Puzzle Multiple Number Representation on the Ability to Recognize Number Symbols in Early Childhood

Nur Fitriani Sapitri[1], Sitti Nurhidayah Ilyas[2], Hajerah[3] , Hasbi[4]

nurfitriani6399@gmail.com, nurhidayah.ilyas@unm.ac.id, hajerah@unm.ac.id, dr.hasbi@un-sultra.ac.id

Early Childhood Education Teacher Education, Universitas Negeri Makassar, Sulawesi Tenggara, Indonesia

Abstract

Recognizing number symbols in early childhood is challenging because their abstract nature does not align with the child's concrete thinking stage. Conventional methods, such as flashcards, have proven less effective because they rely solely on memorization. This study aims to test the influence of Media Puzzle Mix and Match Multiple Number Representation on children's ability to recognize number symbols in the 5-6-year age range. This research method uses a quasi-experiment with a pretest-posttest control group design involving 16 children at Al-Ikhsan Kindergarten. The experimental group consisted of 8 children using a puzzle media with six number representations, while the control group consisted of 8 children using conventional flashcards. Results: Data analysis showed a significant increase ($p < 0.05$) in the experimental group, with an average increase of 22.25% compared with the control group, which was only 5.75%. The conclusion of the Media Puzzle Mix-and-Match Multiple Number Representation is efficacious in improving the ability to recognize number symbols through a multisensory approach aligned with constructivist and dual-coding theories.

Keywords: *Media Mix and Match Puzzle, Multiple Number Representation, Initial Numeracy, Multisensory Media, Number Symbol Recognition*

INTRODUCTION

Early childhood education is integral to a child's cognitive, social, emotional, and physical development. Proper stimulation is essential for future learning success during the golden age. Numeracy skills, particularly the comprehension of number symbols, are among the cognitive skills

developed during early childhood education. This ability is essential for mastering more complex mathematics at the next level of education. However, the recognition of number symbols in early childhood presents many challenges in real-world contexts. According to Piaget's theory, children aged four to six years are in the preoperational stage of cognitive development, during which their thinking remains concrete. Because they are irrelevant within children's frameworks, abstract number symbols are difficult to understand. Preliminary results from observations at Al-Ikhsan Kindergarten Gowa indicate that most students in group B continue to have difficulty identifying and relating numbers to their correct values (Amri et al., 2022; Eka Daryati & Sadiana, 2025).

Children can be stimulated in ways that accommodate their individuality and needs. In child stimulation, various approaches are needed, and early childhood teachers' understanding and the implementation of learning are essential, as each early childhood education student is unique and has different needs. Learning has been adjusted to the needs and abilities of the child so that every child will feel accepted and valued in the learning environment (Ilyas & Lismayani, 2023).

Research by Nur et al. (2022) suggests that numeracy instruction relying solely on memorization can interfere with children's mathematical comprehension. A new learning medium is needed that can compensate for the differences between children's thinking and the abstract nature of number symbols. According to constructivist theory, children learn best through direct experience and interaction with their environment. Media Mix and Match Puzzle with Multiple Number Representation was developed as an innovative solution. This medium integrates six forms of number representation: number symbols, object images, domino dot patterns, dice, grains, and number-word cards. This results in the possibility that it occurs, such as children understanding the concept of numbers from various perspectives, and also activating the multiple intelligences that each child has (Daryati, 2025)

The recognition of number symbols without concrete references tends to encourage children to memorize rather than understand their conceptual meaning. Research shows that mathematical comprehension is more effective when it is built on the interconnections among number words, visual representations, and numerical symbols. Puzzle media offers a fun and interactive approach to associating abstract symbols with real context, thus supporting a more meaningful learning process for children (A. Bayaga & P. Nzuza, 2022).

Traditional approaches, such as flashcards or verbal memorization, are often insufficient to capture a child's attention or support symbolic comprehension. These methods tend to emphasize

memorization rather than conceptual understanding. As stated by Ansari (2025), the development of symbolic numeracy requires more than passive exposure; it involves designing learning tools that enable symbolic manipulation and active representation. The need for symbolic play as a mechanism for the formation of more profound meaning is also supported by Lee (2021), who found that structured play involving substitution and imagination resulted in cognitive improvements in children, including those with special needs.

The innovative media "Puzzle Mix and Match with Double Representation of Numbers" was developed to address the shortcomings of existing pedagogical approaches. The tool presents numbers in various forms, such as images of objects, finger movements, dot patterns, and number symbols, to strengthen neural connections through multimodal input. The puzzle format used summarizes visual, tactile, and linguistic representations in a fun and structured manner, thereby engaging multiple sensory pathways in the child. As emphasized by Bautista et al (2019) the integration of these various representations makes it easier for children to transition from intuitive understanding to more precise symbolic mastery of numbers.

The management and use of learning resources and media are essential; this is especially true for materials in use. One alternative learning medium is used goods. At least they can receive the benefits of used goods that have less meaning in daily life, and have meaning in the form of early childhood learning media (Hajerah, 2018).

This media aligns with the findings regarding the concept. E. Ranzato et al., (2020) Subitizing is the innate ability to recognize small amounts directly without counting. Ranzato identified the number four as the universal cognitive boundary beyond which estimation replaces perceptual accuracy. The grouped dot patterns used in the puzzle are designed to harness children's subitizing abilities and to link the recognition of number symbols to a strong perceptual foundation. Symbolic numerical knowledge, not just the ability to estimate non-symbolically, is a stronger predictor of numeracy performance in the early stages of development(Fadillah & Suryadi, 2025; Fanari, 2023).

This study examines the effectiveness of the Media Puzzle Mix-and-Match in improving early childhood recognition of number symbols at Al-Ikhsan Kindergarten. The primary focus is on testing multifaceted symbolic structures in puzzle format using experimental design. This approach differs from previous research, which generally relied on a single representation, such as numbers or images. The novelty of the study lies in integrating various numerical, visual, tactile, and verbal-

symbolic modalities to strengthen children's numerical cognition through game-based learning.

Previous studies have shown that puzzle media is efficacious in improving the recognition of numbers 1–10 in early childhood. This research expands the empirical foundation by offering a comparative analysis between conventional flashcard-based learning and innovative puzzle-media-based learning. The experimental group received treatment using the Media Puzzle Mix-and-Match, whereas the control group received instruction using a commonly used classroom method (Widayani, 2023; Irwansyah, 2023).

This study tested the hypothesis that the use of the Dual Representation Puzzle Mix-and-Match Media significantly improved children's ability to recognize number symbols. The findings provide a basis for recommendations to early childhood educators to adopt interactive media that integrates a variety of symbolic representations. This approach is considered effective in facilitating concrete understanding while creating a fun and meaningful learning experience for children.

METHODOLOGY

Types of Research

Because the research was conducted in schools using existing classrooms, the researchers employed a quasi-experimental design with an unequal control group. This design involves one class as the experimental group that receives a specific treatment, and one class as the control group that does not receive that treatment. Both classes were measured both before and after treatment. The study involved two groups, namely the experimental group and the control group, which were given a pretest and a posttest.

Research Time and Place

The research was conducted during the even semester of the 2024/2025 school year at Al-Ikhsan Kindergarten in Gowa Regency. This location was chosen because of the difficulty of recognizing number symbols among homogeneous students, to support a smooth research process.

Research Objectives

The study population was all group B children at Al-Ikhsan Kindergarten. The sample comprised 16 children selected via purposive sampling, who were then divided into two groups: 8 in the experimental group and 8 in the control group.

Data Collection Techniques and Instrument Development

Data collection is carried out through three stages:

1. A pretest is carried out before treatment to find out the child's initial ability.

2. Treatment is the experimental group that learned using a mixed-and-matched puzzle with six number representations for five days, with 30-40 minutes per day. Meanwhile, the control group learned using conventional flashcards for the same duration.

3. Posttests are carried out after treatment to measure the improvement of children's abilities.

Data Analysis Techniques

Data were analyzed statistically, descriptively, and inferentially using the Wilcoxon Signed-Rank Test.

DISCUSSION RESULTS

RESULTS

The study began by giving a pretest to both experimental and control groups. Preliminary results showed that both groups had similar baseline knowledge of number-symbol recognition, with most students initially classified as "Good". In the experimental group that used Media Puzzle Mix and Match with Double Number Representation, posttest scores increased significantly. All students showed improvement in their ability to compare number symbols with their representations across four modalities: visual points, fingers, pictures, and numbers. Students who initially have difficulty recognizing the number "7" symbol can then assemble puzzle pieces and state the correct number with confidence. In the control group using conventional flashcards, the increase was more minor. Although some students can improve their number recall, most of their responses remain unchanged.

Table 1.1 Summary of descriptive statistics

Groups	Pretest average score	Posttest Average Score	%
Eksperimen	62,5	87,0	+22,25%
Controls	63,75	69,50	+5,75%

Based on Table 1.1, the experimental group improved learning by a factor of 4 compared with the control group. The Mann-Whitney test was conducted to assess the statistical significance of the difference between pretest and posttest scores within each group. The test results in the experimental group showed a significant difference between pretest and posttest scores ($p < 0.05$), indicating that puzzle media can improve students' ability to recognize number symbols. In this group, there was an

increase not only in scores but also in terms of confidence and independence in completing tasks. The Mann-Whitney test conducted in the control group showed no significant difference in pretest and posttest results. Score enhancement does not support the null hypothesis. This suggests that conventional learning offers some benefits but lacks the multimodal engagement needed to reinforce symbolic learning.

Table 1.2 Summary of Mann-Whitney test results

Groups	p	Remarks
Eksperimen	0,015	Signifikan
Controls	0,015	Signifikan

Table 1.2 shows that the alternative hypothesis (H1) is that the use of Puzzle Mix and Match media has significantly increased the recognition of children's number symbols. In addition to numerical scores, this study analyzed student performance using the developmental levels employed in early childhood assessment: Very Good, Good, and Developing. The test results for the experimental group showed a marked change in category. The pretest score was 37.5%, and the posttest score was 97.5%, indicating that students were classified as Very Good. Based on the test, there was a 50% increase in the number of students in the highest category for number-symbol recognition. Meanwhile, in the control group, the increase in students included in the "Very Good" category only reached 12.5%, and there were two students who were in the "Developing" category, even though they had participated in learning.

Table 1.3 Comparison of Child Development Categories

Category	Experimental Group (%)		Control Group (%)	
	Pretest	Posttest	Pretest	Posttest
Excellent	37,5	87,5	25,0	37,5
Good	45,0	12,5	50,0	43,75
Growing	17,5	0,0	25,0	18,75

Table 1.3 presents the posttest comparison results for the experimental and control groups by developmental category. Table 1.3 shows that the experimental group was overrepresented in the "Excellent" category and contained no students in the "Developing" category.

DISCUSSION

The use of Mix-and-Match Puzzle Media with Double-Number Representation has been shown to significantly improve the ability to recognize number symbols in early childhood. This is evident from the Wilcoxon Signed-Rank test results, which showed statistical significance ($p < 0.05$)

only in the experimental group. It also shows that children who learn symbolically in early numeracy like it when learning is done in a fun, varied, and manipulative way(Irwansyah, 2023).

This aligns with Piaget's constructivist theory, which posits that children learn optimally during the preoperational stage through direct interaction and symbolic play. Puzzle media display various forms of numbers, such as images of elephants, domino or dice patterns, grains (e.g., green beans), and number words, which are connected to children's cognition. This activity involves visual, verbal, and kinesthetic activities that stimulate the child. It also reflects the principle of dual coding theory, which posits that information is easier to understand and remember when encoded through words and actions (Sriastuti & Masing, 2022).

Multisensory integration is a stronger predictor in supporting the development of symbolic than non-symbolic knowledge on initial numeracy performance (Fanari, 2023). In addition, Sokolowski (2022) also shows that the processing of symbolic numbers works more optimally than non-symbolic numbers. This confirms that early training with number symbols, such as those used in this study, can develop a more efficient cognitive system for understanding numbers in early childhood.

The collaboration between children's symbols with dominoes, dice, and number cards also facilitates intuitive numeracy skills, namely subitizing, comparison, and part-whole relations. This visual-spatial representation enables children to perceive numerical structures clearly rather than merely memorizing numbers. This statement is supported by Lombard et al., (2024) which states that the cognitive limits of humans in subitizing become natural biological limits. In addition, archaeological analysis by d'Errico, (2017) it supports the view that symbolic number systems evolved gradually from concrete practices, necessitating a medium that combined real and abstract elements for early childhood.

Number-word cards that address the symbolic-linguistic dimension play an essential role in bridging numeracy and early literacy. Children not only learn to recognize quantities, but also begin to understand the pronunciation of numbers in written form, thus enriching their numerical literacy (Irwansyah, 2023) and Lee (2021) emphasized that structured symbolic games can improve children's social and cognitive functioning, including children with special needs.

This layered symbolic engagement also has emotional and existential meaning. According to Johansson (2013), the loss of symbolic capacity can lead to profound social isolation in aphasia sufferers. On the contrary, children's success in expressing symbols in this study is not only a

cognitive achievement but also a form of self-representation and participation in the educational process. Ballacci (2024), conveying that symbolic representation can shape identity and enhance children's democratic expression.

Indicate that teachers' interpretations of curriculum content affect the purpose of initial numeracy. Learning media, such as puzzles, connect curricular demands with classroom learning practices. The media in this study support a more meaningful approach appropriate to the early childhood developmental stage. Teachers who can use media with a wealth of symbols can convert abstract learning objectives into engaging, concrete experiences.

The effectiveness of symbolic media does not focus solely on visual appeal but also on its level of epistemic transparency (Moller, 2019). The puzzles used in this study fulfill this transparency by presenting forms that are visible and manipulable, thereby allowing children to construct meaning through active exploration. This design aligns with constructivist and democratic learning principles that support instructional and cognitive reflection, by Ballacci (2024) Symbolic value not only functions practically, but also plays a vital role in shaping collective identity and meaning. According to Cannon & Rossiter (2022) in the context of numeracy learning, the mastery of symbols through puzzle media encourages the formation of children's academic identity. This process improves several aspects often overlooked in early childhood education, namely self-confidence and social-educational status.

These findings are also in line with the symbolic richness of ancient cultures found in the lunisolar time representation at Göbekli Tepe (Sweatman ., 2024). The culture suggests that symbolic understanding has become integral to cognitive and social evolution. This analogy underscores the importance of cultivating symbolic thinking early in numeracy, cognitive, social, and cultural development.

This research yielded several findings, but it remains limited. The relatively short duration of the intervention of five days and the small sample size of 16 children limited the scope of generalization of findings. Some children also have difficulty distinguishing numbers with similar shapes, such as 6 and 9, underscoring the importance of the teacher's role in guiding children through the proximal development. The effectiveness of symbolic learning is also greatly influenced by its sustainability and the context of its implementation. This is because a deep understanding can only be achieved through a process that is consistent and relevant to children's daily experiences. Through

this study, it is hoped that further research can investigate how the long-term use of this multimodal symbolic media affects several aspects, such as fluency in arithmetic, reasoning, and problem-solving. In addition, other researchers can examine the role of this medium in its cross-cultural relevance and inclusivity across various social and linguistic contexts t zone (Taukeni ., 2019).

In summary, this study confirms that Media Puzzle Mix-and-Match with Double Representation of Numbers not only facilitates the recognition of number symbols but also fosters symbolic competence, multimodal understanding, learning agency, and cultural participation. Symbolic representation is not just a learning feature, but also a cognitive, social, and developmental need in early childhood education.

CONCLUSION

The application of Mix and Match Puzzle Media with Double Number Representation has been shown to improve early childhood ability to recognize number symbols significantly. This increase occurred only in the experimental group that received treatment in the form of various representations of number symbols, images of concrete objects, dot patterns (dominoes and dice), grains, and number-word cards that are symbolic, visual, and tactile. These findings are consistent with the theory of early childhood cognitive development, which affirms the importance of real-life, experience-based, multisensory learning. Puzzle media facilitates the construction of numerical meaning through fun, exploratory, and contextual activities. The impact of this medium is substantial across several cognitive and social-emotional domains, including interaction, learning motivation, and children's confidence in using number symbols.

REFERENCES

Afif, N., Firdaus, F., Nurbaiyana, N., & Aswati, N. (2022). Media puzzle angka sebagai alternatif untuk menstimulasi perkembangan kognitif dalam menghitung dan mengenal angka pada anak di sentra wirajaya makassar. *Devote: Jurnal Pengabdian Masyarakat Global*, *1*(2), 32–36. https://doi.org/10.55681/devote.v1i2.335

Amri, N. A., Amalia, I., & Marup, M. (2022). Meningkatkan kemampuan mengenal lambang bilangan melalui kegiatan bermain angka bergambar. *Jurnal Panrita*.

Ansari, D. (2025). The importance of numerical symbols for the development of mathematical skills. *MedUNAB*, *27*(3), 262–267. https://doi.org/10.29375/01237047.5393

Ballacci, G. (2024). Konstruktivisme, demokrasi dan representasi simbolik: Sebuah perspektif

formal/stilistis. *Representation*, *60*(1), 17–34.

Bautista, A., Habib, M., Ong, R., Eng, A., & Bull, R. (2019). Multiple Representations in Preschool Numeracy: Teaching a Lesson on More-or-Less. *Pacific Early Childhood Education Research Association*, *13*(2), 95–122. https://doi.org/10.17206/apjrece.2019.13.2.95

Bayaga, A., & Nzuza, P. (2022). Examining Challenges Associated with Numerical Cognition in Early Years Challenges Associated with Numerical Cognition in Early Years. *International Journal of Research in STEM Education*.

Cannon, B. J., & Rossiter, A. (2022). Mengurai teka-teki kapal induk Jepang: Memanfaatkan nilai simbolik kapal induk. *Asian Security*, *18*(1), 20–37.

Daryati, M. (2025). The Effectiveness of Interactive Learning Media in Improving Early Childhood Numeracy Skills. *JURNAL PENA PAUD*, *6*(1), 1–13. https://doi.org/10.33369/jpp.v6i1.41166

d'Errico, F. (2017). Dari pemahaman angka ke simbol angka: Perspektif arkeologi. . *Philosophical Transactions of the Royal Society B: Biological Sciences*, *373*(1740).

E. Ranzato, A. Tolmie, & J. Herwegen. (2020). Perceptual subitizing and conceptual subitizing in Williams syndrome and Down syndrome: Insights from eye movements. . *Research in Developmental Disabilities*.

Eka Daryati, M., & Sadiana, M. (2025). The Influence of Cooking Activities on the Introduction of Healthy Food for Early Childhood Education. *HealthSmart: Jurnal Kesehatan Masyarakat*, *1*(1), 14–26. https://doi.org/10.64146/1js56e90

Fadillah, & Suryadi, D. (2025). The Relationship Between Parenting Patterns and Balanced Nutritional Intake with Nutritional Status of Young Children. *HealthSmart: Jurnal Kesehatan Masyarakat*, *1*(1), 52–65. https://doi.org/10.64146/7g6t1b06

Fanari, C. M. (2023). Prediktor simbolik dan non-simbolik dalam tugas garis bilangan pada anak TK Italia. *Frontiers in Psychology*.

Hajerah. (2018). Pembuatan Media Pembelajaran Dengan Menggunakan Bahan Bekas pada Guru TK di Kabupaten Maros. . *Prosiding Seminar Nasional Lembaga Pengabdian Kepada Masyarakat Universitas Negeri Makassar* , 680–683.

Ilyas, S. N., & Lismayani, A. (2023). Implementation of Differentiated Learning at TK Islam Plus E-School. . *Journal of Education and Learning, Vation*, *3*(4), 586–591.

Irwansyah, I. (2023). Pengembangan media pembelajaran puzzle angka untuk siswa disleksia sekolah dasar: Penelitian subjek tunggal. *Jurnal Didaktik Matematika*, *10*(2), 170–186.

Johansson, M. (2013). Afasia – kesepian eksistensial: Studi tentang kehilangan dunia simbol. . *International Journal of Qualitative Studies on Health and Well-Being*, *8*(1).

Lee, G. T. (2021). Mengatur aktivitas bermain dengan benda yang hilang untuk meningkatkan permainan simbolik substitusi pada anak dengan autisme. *Disability and Rehabilitation*, *43*(22), 3199–3211.

Lombard, A., Huyghe, R., & Gygax, P. (2024). Morphological productivity and neological intuition. *Glossa Psycholinguistics*, *3*(1). https://doi.org/10.5070/G60111291

Moller, A. (2019). Teka-teki transparansi dan bagaimana menyelesaikannya. *Philosophy & Social Criticism*, *45*(4–5), 482–500.

Nur, I. R. D., Herman, T., & Dahlan, T. H. (2022). *Numeracy Literacy in Early Childhood: An Investigation in Arithmetic, Geometry and Patterns in Early Stage.* .

Sokolowski, H. M. (2022). Simbol angka diproses lebih otomatis daripada besaran numerik non-simbolik: Temuan dari tugas Stroop simbolik-non-simbolik. *Acta Psychologica*, *228*(103644).

Sriastuti, L., & Masing, M. (2022). *Application of jean piaget's cognitive learning theory in early childhood education.*

Sweatman, M. B. (2024). Representasi kalender dan waktu di Gobekli Tepe dan Karahan Tepe mendukung interpretasi astronomis simbolismenya. *Time Adn Mind*, *17*(3–4), 191–247.

Taukeni, S. G. (2019). Providing remedial support to primary school learners within their zone of proximal development. . *South African Journal of Childhood Education*.

Widayani, S. (2023). Upaya Meningkatkan Kemampuan Mengenal Konsep Lambang Bilangan Melalui Media Puzzle Lambang Bilangan Pada Anak. *Jurnal Edu Talenta*, *2*(1), 55–67. https://doi.org/10.56129/jet.v2i1.34