INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES

Vol 14, Issue 11, (2024) E-ISSN: 2222-6990

Contents of Pre-Number Skills in Malaysian Preschools

Julianty Idris[1], Norly Jamil[2]

[1,2]Fakulti Pembangunan Manusia, Universiti Pendidkan Sultan Idris, Tanjong Malim, Perak, Malaysia

Coressponding Author Email: norly@fpm.upsi.edu.my

To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v14-i11/23554 DOI:10.6007/IJARBSS/v14-i11/23554

Published Date: 25 November 2024

Abstract

This conceptual paper will discuss the content of pre-number skills for preschool children aged five to six years in Malaysia. Pre-number skills in Malaysia include matching objects, comparing quantities of objects, performing seriation, recognizing and constructing patterns, and understanding the concept of conservation. The content of pre-number skills from several international bodies and researchers will also be discussed. This study provides a comprehensive assessment of the key components of pre-number skills, including matching objects, comparing quantities of objects, performing seriation, recognizing and constructing patterns, and understanding the concept of conservation. The study shows that each of these components plays an important role in children's early mathematical development and supports broader cognitive skills. The main contribution of this article is to enhance knowledge about pre-number skills in understanding their content in preschool education. The implications of this study indicate that a deep understanding of pre-number skills needs to be incorporated into early childhood curricula. Knowledge of the content in forming thesepre-number skills will help educators and parents plan and apply appropriate and challenging mathematical activities to build pre-number skills in children.

Keywords: Pre-Number Skills, Matching Objects, Comparing Quantities of Objects, Seriation, Patterns

Early Mathematics Education

Early Mathematics Education at the preschool level aims to introduce students to fundamental concepts in mathematics. The Early Mathematics curriculum covers pre-numberexperiences, number concepts, number operations, the value of money, concepts of time, and spatial awareness. These topics form the foundation for Early Mathematics learning. Suchfoundational knowledge is crucial for young children as it fosters critical, creative, and innovative thinking, skills essential for problem-solving in their academic and everyday lives (BPK, 2017).

Developing Early Mathematics skills is vital because these abilities provide a strong foundation for future learning (Björklund et al., 2020; Passolunghi & Costa, 2016; Stipek & Valentino, 2015). However, deficits in early mathematical skills are frequently observed among children who have not mastered basic mathematical concepts. These deficits often lead to a lack of interest in mathematics, resulting in challenges for these children navigating the mainstream education system (Nelwan et al., 2022; Sufa et al., 2021).

Pre-Number Skills

Pre-number skills are understood in various ways, but researchers generally agree on their importance in early childhood development, as they help children begin to grasp key mathematical concepts. These skills encourage children to explore numbers, including the meaning of numbers, relationships between numbers, counting, quantities, and number combinations and representations (Salminen et al., 2018). Developing strong pre-number skills enables children to understand counting and cardinality, count flexibly, compare and estimate quantities, and manipulate numbers and sets differently. This foundational understanding is essential for problem-solving (Geary et al., 2018).

Pre-number skills are a critical foundation for children's mathematical development and significantly impact their later mathematical achievement (Seitz & Weinert, 2022). These skills involve understanding number concepts, the relationships between numbers, and basic mathematical operations before formal instruction begins (Jordan et al., 2009). Early mastery of these skills predicts future mathematics success (Geary et al., 2018). However, despite their recognized importance, many children struggle to master pre-number skills (Raudenbush et al., 2020). Recent studies indicate that 15-20% of preschool children experience difficulties with pre-number skills, leading to ongoing challenges in mathematics learning (Geary, 2018). Furthermore, a significant gap exists in the mastery of pre-number skills among children from different socioeconomic backgrounds (Idris & Jamil, 2024).

While various interventions and programs have been developed to enhance pre-number skills, their effectiveness has been inconsistent (Svane et al., 2023). A limited understanding of the factors influencing the development of these skills and their interaction with external factors, such as the learning environment and individual differences, has made it difficult to design effective interventions (Purpura & Reid, 2016). This conceptual article seeks to analyzethe content of pre-number skills for preschool children aged five to six in Malaysia and explorethe curriculum on pre-number skills both locally and internationally.

The article aims to contribute to early mathematics education by synthesizing recent pre-number skills research, suggesting future research directions, and offering practical implications for educators and policymakers. The article's structure includes sections on early mathematics education, the definition and components of pre-number skills, a literature review of standard content, and conclusions and implications. By exploring these areas, this conceptual article hopes to deepen the understanding of pre-number skills and assist educators and parents in planning and implementing appropriate, challenging mathematical activities that support children's development.

The following table (Table 1) provides various definitions of pre-number skills based on different curricula.

Table 1
Definitions and Elements in Pre-number Skills

Curriculum	Pre-Number Skills Definition	Key Elements
Nurturing Early Learners (NEL) Framework Singapore (2013)	Basic mathematical abilities children develop include recognizing and using numbers, understanding number relationships, counting accurately, and identifying patterns and shapes.	1. Enjoy learning and applying numeracy concepts 2. Understand relationships and patterns 3. Develop counting skills and number sense 4. Understand basic shapes and spatial concepts
NAEYC (National Association for the Education of Young Children) (2012), USA	A child-centered, play-based, and developmentally appropriate approach to building an understanding of early mathematical concepts.	1. Counting 2. Number recognition 3. Number formation 4. Comparing quantities 5. Basic mathematical operations
Early Years Foundation Stage (EYFS) (2021), UK	Developing a strong foundation in number and spatial skills for future mathematical growth.	1. Numbers 2. Shape, space, and measurement 3. Patterns 4. Positive attitudes towards mathematics
Te Whāriki (2017), New Zealand	Early mathematical concepts and skills developed by children before formal numeracy education.	1. Exploration and play 2. Communication and language 3. Numbers and patterns 4. Shape, space, and measurement
Preschool Standard Curriculum (KSPK) (2017), Malaysia	Basic mathematical concepts introduced to preschool children.	1. One-to-one correspondence 2. Comparison 3. Seriation 4. Patterns 5. Conservation

Based on the comparison table above, a comparative analysis of early childhood education curricula from various countries reveals several important conclusions regarding the approach to pre-number skills. First, there is a significant commonality among the curricula analyzed, all of which emphasize basic pre-number concepts, particularly in comparing the quantity of objects, patterns, shape and space. This highlights a global consensus on the importance of these foundational concepts for early mathematical development (Ministry of Education Singapore, 2013; NAEYC, 2019; EYFS, 2021; Te Whāriki, 2017; KSPK, 2017). The universal recognition of these elements underscores their essential role in supporting children's early cognitive development in mathematics.

Secondly, there is a prevailing trend toward active learning, emphasizing play-based and exploratory learning methods. This approach aligns with contemporary educational understanding that children learn more effectively through hands-on experiences and engaging, meaningful activities (NAEYC, 2019; Te Whāriki, 2017; KSPK, 2017). However, each curriculum exhibits unique features. For instance, the Malaysian National Preschool Standards Curriculum (KSPK, 2017) is more detailed in outlining specific mathematical concepts, while the UK's Early Years Foundation Stage (EYFS) emphasizes fostering positive attitudes toward mathematics, and New Zealand's Te Whāriki focuses on the development of mathematical language (KSPK, 2017; EYFS, 2021; Te Whāriki, 2017).

Furthermore, many curricula view pre-number skills as part of a child's holistic development, encompassing cognitive, social, and emotional growth rather than focusing solely on technical mathematical skills (EYFS, 2021; Te Whāriki, 2017; KSPK, 2017).

Additionally, there is variation in the age ranges targeted by different curricula, reflecting the understanding that the development of pre-number skills occurs at different rates for different children. For example, the NAEYC framework encompasses children from birth to age eight, KSPK covers children aged 4+ to 5+, while Te Whāriki encompasses children aged 0 to 5 years (NAEYC, 2019; KSPK,2017; Te Whāriki, 2017). This variation acknowledges the diverse developmental trajectories of young learners.

Lastly, some curricula, such as NAEYC, introduce basic mathematical operations earlier, signaling a shift toward preparing children for more formal mathematical learning at a younger age (NAEYC, 2019). In conclusion, while there are shared foundations in teaching pre-number skills, each curriculum incorporates distinct approaches that reflect the educational context, culture, and local understanding of child development. This suggests that there is no *"one-size-fits-all"* model for teaching pre-number skills, and educators must tailor their methods to the specific needs and contexts of the children in their communities.

The following is a table of summarizing the similarities and differences in pre-number skills based on the analysis of the given curricula:

Table 2
Similarities and Differences in Pre-number Skills Across Curricula

Aspect	Similarities	Differences
Basic Concepts	• Shapes and spatial awareness (NEL, EYFS, TeWhāriki) • Patterns (NEL,NAEYC, EYFS, Te Whāriki, KSPK) • Quantity comparison (NAEYC, KSPK, EYFS, NEL, Te Whāriki)	• Conservation (KSPK) • Basic mathematical operations (NAEYC)
Teaching Approach	All curricula emphasize pre-numbe learning through concrete experiences, play, and real-world contexts. • Play-based learning (NAEYC,Te Whāriki,KSPK)	• Focus on positive attitudes (EYFS) • Emphasis on mathematical language (Te Whāriki)

Note: NEL = Nurturing Early Learners Framework (Singapore); EYFS = Early Years Foundation Stage (UK); NAEYC = National Association for the Education of Young Children (USA); KSPK = National Preschool Standard Curriculum (Malaysia); Te Whāriki = Early Childhood Curriculum (New Zealand).

As shown in the Table 2 above, summarizes the main similarities and differences in approaches to pre-number skills across the analyzed curricula. It highlights that while there is consensus on certain fundamental aspects, each curriculum possesses unique characteristics that reflect its respective educational and cultural context."

Pre-Number Content Standards
The National Preschool Standard Curriculum (KSPK, 2017) outlines content standards for pre-number skills, which include object matching, comparing quantities, making seriations, recognizing patterns, and understanding consistency.

Matching Objects
Matching objects refers to the ability of children to pair one object with another based on equivalence. This skill is fundamental in pre-number development as it aids children in grasping the concepts of numbers and quantity. In the context of early education, this skill is important because it forms the basis for the development of more complex mathematical skills such as arithmetic and numeracy. Research by Sokolowski et al., (2021) highlights that training in object matching enhances children's comprehension of numbers as quantitative representations. Studies show that children who are actively involved in object matching activities tend to better understand that numbers are more than just a sequence of symbols, but also represent actual quantities that can be associated with sets of objects. Similarly, Uttal et al., (1997) found that using manipulatives, such as blocks and number cards, assists in teaching object matching, reinforcing one-to-one correspondence and fostering abstract mathematical thinking.

Keen (2011), explored the broader cognitive benefits of object matching, finding that it improves mathematical abilities and enhances problem-solving and critical thinking. This study

shows that children who regularly participate in object matching activities not only improve their math skills, but also their ability to solve problems that require logical and deductive reasoning.

Overall, these studies highlight the importance of object matching as a fundamental skill in pre-number development and show that this activity influences not only mathematical understanding but also broader aspects of cognitive development. Integrating object matching with manipulatives into early education curricula is critical for maximizing children's cognitive and mathematical development (Boz et al., 2020).

Comparing Quantities

Comparing quantities involves the ability to discern differences between sets of objects based on numerical or physical properties such as size, weight, or length. This skill is the basis for more advanced mathematical concepts like addition, subtraction, and measurement. It also helps children to develop the logical thinking they need to solve everyday problems. Hannula et al (2022), demonstrated that children who engage in activities comparing quantities develop stronger mathematical literacy. This study found that activities involving quantity comparisons, such as comparing "greater than", "less than"" or "equal to"," play an important role in strengthening children's understanding of basic mathematical concepts. In particular, this study highlights those children who regularly engage in these comparison activities show an improvement in their ability to understand and use quantitative concepts in a broader mathematical context, including measurement and arithmetic operations. This shows that early training in quantity comparison can have a positive effect on mathematical success at the next educational level (Ferres-Forga et al., 2022).

Comparing the quantities of objects can also be known as number estimation skills (Jamil et al., 2022). In this object comparison, the children learn to estimate and differentiate between the terms "much" and "little" This skill, known as number estimation, begins developing in infancy (Lau, 2021; Xu et al., 2005). The ability to estimate numbers is a very important component in the process of children's development of early mathematical skills (Jordan et al., 2012; Sella et al., 2016). Children's mastery of the number estimation system has a direct impact on their future mathematical achievement (Jordon et al., 2006). Libertus et al., (2011) found a direct relationship between number estimation skills in children aged 3 to 5 and their later mathematical abilities, even after controlling for age and verbal skills. Similarly, Fuhs and McNeil (2013) reported a correlation between estimation skills and mathematical achievement in preschool children from low-income families, although the relationship was modest. While the relationship was found to be quite weak, Fuhs and McNeil (2013) still believe that number estimation skills are very important in providing children with early math learning experiences. They therefore suggested giving preschool children formal learning experiences with this estimation system.

Schwartz et al., (2021) found that proficiency in non-symbolic estimation in early years predicted children's future mathematical success, including their ability to recognize numbers and symbols. Other studies, such as Noordende et al., (2020), confirm that strong number estimation skills in preschool predict later mathematical competence (Mielo & Prado, 2022; Ouyang et al., 2021).

Seriation

Seriation refers to the ability to arrange objects in a specific order based on criteria such as size, length, or weight, either from smallest to largest or vice versa. This skill is essential for early childhood cognitive and mathematical development as it helps children grasp the concepts of sequence and ordinal relationships. These concepts form the foundation for many formal mathematical ideas, including sequential numbers, measurement, and logical thinking.

A Wilkins et al (2020), study found that preschool children with strong seriation abilities performed better on mathematical tasks requiring logical thinking and sequencing. Children proficient in seriation demonstrated a stronger understanding of sequences and could apply this understanding within mathematical contexts. Seriation helps children deepen their comprehension of the relationships between objects (Pasnak et al., 2015) and how these objects interact in a sequence. This understanding is a foundation for more complex mathematical skills, such as counting, measurement, and deductive reasoning. The study highlights the significance of including seriation training in the preschool curriculum to enhance children's cognitive and mathematical development (Desoete et al., 2009).

In their research, Rabindran and Madanagopal (2020), explored the role of seriation in children's cognitive development, particularly concerning logical thinking and problem-solving. Their study found that seriation activities go beyond the physical arrangement of objects; they improve children's ability to make logical decisions in situations requiring deductive thinking.When children engage in seriation tasks, they learn to arrange objects and enhance their skills in formulating and applying logical strategies (McGonigle-Chalmers & Kusel, 2019). Seriation activities help children identify patterns, predict sequences, and solve problems based on object relationships. The study emphasizes the importance of seriation skills as a foundation for broader cognitive development, enabling children to apply logic and analysis in various contexts (Domingo et al., 2021).

Recent studies underscore the critical role of seriation in early childhood education, forming the basis for more complex logical and mathematical thinking. Research indicates that seriation training helps children understand sequence, ordinal relationships, and logic, which is essential for formal mathematics, science, and problem-solving skills (Prihartanta et al., 2022). Therefore, incorporating seriation activities into preschool curricula supports children's broader cognitive and mathematical growth (Mahyuddin & Mainofriwita, 2023).

Pattern Recognition and Creation

Pattern recognition and creation are important skills in early mathematics development that involve identifying and creating repeating patterns in groups of objects or numbers. These activities help children understand structures and relationships in data and lay the foundation for more complex mathematical learning in the future.

Pattern recognition is the process of identifying repeating sequences or structures in data. Examples of patterns include sequences of colours, shapes, or numbers that follow a specific order, such as an AAB pattern (e.g., red, red, blue) or an ABC pattern (e.g., circle, square, triangle). Identifying patterns is fundamental to mathematical development because it helps children understand how objects or numbers are related and how they repeat in predictable structures.

Pattern creation involves the skill of arranging objects according to specific, recognizable patterns, allowing children to construct complex patterns based on simpler ones. Pattern recognition and creation promote cognitive skills such as logic, analytical thinking, and creativity. These activities provide the foundation for understanding more complex mathematical concepts like algebra and geometry.

Recognizing patterns is crucial to early mathematics learning because it forms the foundation for higher mathematical thinking. Many educators agree that pattern recognition skills significantly impact children's cognitive abilities (Hendricks et al., 2006; Papic, 2007). Without recognising and constructing patterns, children may struggle to master mathematics meaningfully and efficiently. Knowledge of patterns enhances children's reasoning abilities and sensitivity to object similarities and differences (Papic, 2007). It also helps them recognize repetition, understand the addition or subtraction of objects (Economopoulos, 1998), and increase their understanding of relationships between objects (Threlfall, 1999). Pattern recognition knowledge and skills also assist in the early development of algebraic thinking (Papic, 2007). Clements and Sarama (2007) state that pattern construction fosters analogical thinking, closely connected to mathematics learning. Through pattern recognition, children can understand sequences and rules, anticipate unstructured situations, comprehend relationships, and make generalizations. In this regard, Gadzichowski (2012) suggests that an initial step in incorporating pattern-making as an aspect of children's cognitive development is identifying the types of patterns that are easy or difficult for them.

Although mathematical patterns provide a foundational structure for the development of formal mathematical competence, past studies have found that children are not given appropriate opportunities for meaningful pattern-building activities in the classroom (Waters, 2004). In Malaysia, most studies conducted in early childhood do not focus on mathematical patterns as the main topic but include them as part of broader studies (Sharifah Norul Akmar & Juliana, 2011; Norhaizian & Sharifah Norul Akmar, 2011).

Understanding the Conservation Concept

Understanding the conservation concept is an important component of pre-number skills, referring to the understanding that certain properties of objects—such as quantity, mass, and volume—remain unchanged despite changes in their shape or arrangement. The concept of conservation is fundamental to early mathematical cognitive development and is an important step in children's mathematics learning.

Conservation of Quantity

Conservation of quantity refers to the understanding that the number of objects in a set remains constant despite their arrangement or appearance changes. For example, if a row of ten coins is rearranged into a longer line, the number of coins remains unchanged even though the arrangement has changed. Mastery of this concept is important in helping children understand number stability, the basis for arithmetic operations.

Conservation of Mass

Conservation of mass involves recognizing that the mass of an object remains constant regardless of changes in its shape or form. For example, if a lump of clay is moulded into a

different shape, its mass does not change. Understanding the conservation of mass is essential for grasping more complex concepts in the physical sciences and measurement.

Conservation of Volume

Conservation of volume refers to the understanding that the volume of a liquid or substance remains the same when transferred from one container to another, even if the shape or size of the container changes. For example, pouring water from a tall, narrow glass into a short, wide glass does not change the volume of the water. Understanding this concept is important for grasping the basic measurement principles and spatial reasoning.

Byrne and Ramchandani (2022), explored the development of quantity conservation among young children, emphasizing the role of hands-on and manipulative activities in facilitating this understanding. The study found that children who participated in activities involving the physical manipulation of objects exhibited a more advanced understanding of the conservation of quantity than their peers who did not engage in such activities. Specifically, the researchers highlighted that engaging with tangible, manipulable objects allows children to experience firsthand that the quantity of a set remains constant despite changes in arrangement or appearance. This hands-on approach is important for reinforcing the concept of conservation of quantity, as it provides children with concrete experiences that support their cognitive development in understanding numerical stability (Lozada & Carro, 2016; May & Tisshaw, 1977).

Watanabe (2019), examined how understanding the conservation of mass and volume influences early childhood mathematics performance. This study showed that children who demonstrated a strong understanding of the conservation of mass and volume tended to perform better on mathematical tasks involving measurement and comparison. Specifically, these children were more efficient at solving problems that required them to apply the concept of conservation in practical contexts. For example, they could compare quantities more accurately and understand the constancy of the properties of objects despite changes in shape or container. These findings emphasize the importance of teaching conservation concepts early, as a strong understanding of these principles is associated with better abilities in measurement and comparative reasoning in mathematics (Watanabe, 2017).

Conservation is an important concept in early cognitive development that supports many aspects of mathematical and scientific reasoning. It involves understanding that certain properties of objects remain unchanged despite changes in their appearance or arrangement. Mastery of the concept of conservation is associated with better performance on mathematical tasks and forms the foundation for more advanced cognitive skills. Integrating activities that promote an understanding of conservation into early childhood education can significantly enhance children's mathematical reasoning and cognitive development.

Conclusions and Implications

This study provides a comprehensive assessment of the key components of pre-number skills, including matching objects, comparing quantities, seriation, recognizing and constructing patterns, and understanding the concept of conservation. The results indicate that each component is important in early childhood mathematical development and supports broader cognitive skills.

Research shows that matching objects, including one-to-one correspondence, is fundamental to early mathematical computation and understanding object relationships (Hannula & McMullen, 2022). The ability to compare quantities allows children to grasp the concept of relativeness in mathematics, which is important for arithmetic and measurement operations (Ferres-Forga et al., 2022). Seriation activities enhance understanding of the order and relationships among objects and support the logical thinking required for mathematical problem-solving (Wilkins et al., 2020). Recognizing and constructing patterns promotes cognitive skills such as logic and creativity, providing a foundation for learning more complex mathematics like algebra and geometry (Papic, 2007). Conservation concepts, including conservation of quantity, mass, and volume, are important foundations in early mathematics development that influence children's abilities in measurement and comparison (Byrne & Ramchandani, 2022).

The implications of this study suggest that a deep understanding of pre-number skills needs to be incorporated into early childhood curricula. Educators should emphasize using manipulatives and hands-on activities to help children understand basic mathematical concepts such as conservation of quantity and comparing quantities. Additionally, providing a variety of teaching approaches can meet individual needs and promote a deeper understanding of mathematical concepts. Integrating pre-number skills into all aspects of early mathematics learning will strengthen the connection between concepts and their practical applications.

Future studies are recommended to conduct longitudinal research that assesses how pre-number skills influence long-term mathematics achievement and cognitive development. Investigations into the effectiveness of interventions to improve pre-number skills among children from different backgrounds, including those of low socioeconomic status, are also suggested. Furthermore, research needs to be conducted to understand how cultural contexts influence the development of pre-number skills and the adaptation of teaching strategies. An assessment of the impact of using educational technology in teaching pre- number skills and how technology can enrich children's learning experiences must also be considered.

This study provides significant contributions to the theory and practice of early childhood education, particularly in the domain of prenumber skills. From a theoretical perspective, the research strengthens Piaget's cognitive development theory, which emphasizes that children at the preoperational stage construct their understanding through concrete experiences. This study systematically analyzes key components of prenumber skills, such as object matching, comparing quantities, seriation, recognizing and constructing patterns, and understanding the concept of conservation. The findings illustrate how each component supports children's cognitive development. From a contextual perspective, this research contributes to improving early childhood education practices in Malaysia. To provide a comprehensive perspective, this study emphasizes both the strengths and areas for improvement in the National Preschool Curriculum Standard (KSPK) concerning the development of pre-number skills, the study helps educators and policymakers identify areas for enhancement. The findings on the importance of manipulatives and hands-on activities in enhancing children’s understanding are consistent with Piaget's view that children learn more effectively when given opportunities to actively explore through concrete experiences. This approach offers practical guidance for educators to design activities aligned with the cognitive development levels of children.

Overall, this study plays a crucial role in addressing existing knowledge gaps and establishing a foundation for future research. Globally, the study contributes to the literature on early childhood education by providing insights into how concrete experiences can be used to strengthen the teaching of prenumber skills. Locally, it enhances the effectiveness of curriculum design and teaching practices in Malaysia, supporting more comprehensive early mathematical development for children.

References

Bahagian Pembangunan Kurikulum Kementerian Pendidikan Malaysia. (2017). Kurikulum Standard Prasekolah Kebangsaan. Pendidikan Prasekolah Dokumen Standard Kurikulum dan Pentaksiran. Kementerian Pendidikan Malaysia.

Boz, M., Uludağ, G., & Erdoğan, S. (2020). The effect of the manipulative materials on the early mathematical skills. Bartın University Journal of Faculty of Education, 9(3), 492- 500.

Björklund, C., van den Heuvel-Panhuizen, M., & Kullberg, A. (2020). Research on early childhood mathematics teaching and learning. ZDM, 52, 607-619.

Byrne, E., & Ramchandani, P. (2022). Educational interventions involving physical manipulatives for improving children's learning and development: a scoping review. Review of Education. https://doi.org/10.31234/osf.io/ztsyh.

Chavira-Quintero, R., & Olais-Govea, J. (2023). Analysis of Content Knowledge Categories in Preservice Teachers When Teaching the Concept of Number in Preschool. Sustainability. https://doi.org/10.3390/su15053981.

Clements, D.H. & Sarama, J. (2007). Building Blocks. (Computer Software) Colombus, oh SRa, Mc. graw hill

Desoete, A., Stock, P., Schepens, A., Baeyens, D., & Roeyers, H. (2009). Classification, Seriation, and Counting in Grades 1, 2, and 3 as Two-Year Longitudinal Predictors forLow Achieving in Numerical Facility and Arithmetical Achievement?. *Journal of Psychoeducational Assessment*, 27, 252 - 264. https://doi.org/10.1177/0734282908330588.

Domingo, J. G., Ibañez, E. D., Subia, G., Pentang, J., Pascual, L. E., Mina, J. C., & Liangco, M. Economopoulos, K. (1998). Early childhood corner: What comes next? The mathematics of pattern in kindergarten. *Teaching children mathematics*, *5*(4), 230-233.

Ferres-Forga, N., Halberda, J., Batalla-Ferres, A., & Bonatti, L. (2022). Improving mathematics performance in 7-year-old children: Training the mapping from estimated quantities to Arabic digits. *J. Numer. Cogn.*, 8, 123-147. https://doi.org/10.5964/jnc.8075.

Fuhs, M. W., & McNeil, N. M. (2013). ANS acuity and mathematics ability in preschoolers from low-income homes: Contributions of inhibitory control. *Developmental science*, *16*(1), 136-148.

Gadzichowski, K. M. (2012). Patterning abilities of first grade children: effects of dimension and type. *Creative Education 3*(5): 632-635.

Geary, D., vanMarle, K., Chu, F., Rouder, J., Hoard, M., & Nugent, L. (2018). Early Conceptual Understanding of Cardinality Predicts Superior School-Entry Number-System Knowledge. *Psychological Science*, 29, 191-205.https://doi.org/10.1177/0956797617729817.

Hannula-Sormunen, M. M., Brezovszky, B., Lehtinen, E., & McMullen, J. (2022). Promoting Adaptive Number Knowledge Through Deliberate Practice in the Number. In *Games and Learning Alliance: 11th International Conference, GALA 2022, Tampere, Finland, November 30–December 2, 2022, Proceedings* (Vol. 13647, p. 127). Springer Nature.

Hannula-Sormunen, M. M., Lehtinen, E., & Räsänen, P. (2015). Preschool children's spontaneous focusing on numerosity, subitizing, and counting skills as predictors of their mathematical performance seven years later at school. *Mathematical Thinking and Learning, 17*(2–3), 155–177. https://doi.org/10.1080/10986065.2015.1016814.

Hendricks, C., Trueblood, l. & Pasnak, R. (2006). effects of teaching patterning to 1st graders. *Journal of Researchin Childhood Education* 21(1): 79-89. (eRiC document Reproduction Service No eJ751970).

Idris, J., & Jamil, N. (2024). Development of a Pre-Number Skill Teaching Activity Model Based on VAK Learning Style in Preschool: A Needs Analysis. *Jurnal Pendidikan Sains dan Matematik Malaysia*, *14*(1), 104-115.

Jamil, N., Rohaizad, N. A. A., Ghazali, M., & Yusof, R. (2022). Tahap Kemahiran Sistem Anggaran Nombor Kanak-Kanak 4 Tahun di Taska dan Tabika Permata KEMAS. *JurnalPendidikan Awal Kanak-kanak Kebangsaan*, *11*(2), 28-40.

Jordan, N. C., Glutting, J., Dyson, N., Hassinger-Das, B., & Irwin, C. (2012). Building kindergartners' number sense: A randomized controlled study. *Journal of educational psychology, 104(3), 647.*

Jordan N. C., Kaplan D., Ramineni C. & Locuniak, M. N. (2009). Early math matters: kindergarten number competence and later mathematics outcomes. *Developmental Psychology* 45, 850-867.

Jordan, N. C., Kaplan, D., Nabors Oláh, L., & Locuniak, M. N. (2006). Number sense growth in kindergarten: A longitudinal investigation of children at risk for mathematics difficulties. *Child development*, *77*(1), 153-175.

Keen, R. (2011). The development of problem solving in young children: a critical cognitive skill.. *Annualreviewofpsychology*, 62,1-21. https://doi.org/10.1146/annurev.psych.031809.130730.

Kurikulum Standard Prasekolah Kebangsaan. (2017). *Kurikulum Standard Prasekolah Kebangsaan (KSPK)*.Putrajaya: Bahagian Pembangunan Kurikulum, Kementerian Pendidikan Malaysia

Libertus, M. E., Feigenson, L., & Halberda, J. (2011). Preschool acuity of the approximate number system correlates with school math ability. *Developmental science*, *14*(6), 1292-1300.

Lozada, M., & Carro, N. (2016). Embodied Action Improves Cognition in Children: Evidence from a Study Based on Piagetian Conservation Tasks. *Frontiers in Psychology*, 7. https://doi.org/10.3389/fpsyg.2016.00393.

Mahyuddin, N., & Mainofriwita, M. (2023). Pengenalan Konsep Matematika Berbasis Seriasi Melalui Media Logo Pada Anak. *JURNAL BUNGA RAMPAI USIA EMAS*. https://doi.org/10.24114/jbrue.v9i2.52550.

May, R., & Tisshaw, S. (1977). Variations of Learning-Set Training and Quantity Conservation.. *Child Development*, 48, 662-667. https://doi.org/10.1111/J.1467- 8624.1977.TB01215.X.

McGonigle-Chalmers, M., & Kusel, I. (2019). The Development of Size Sequencing Skills: An Empirical and Computational Analysis.. *Monographs of the Society for Research in Child Development*, 84 4, 7-202 . https://doi.org/10.1111/mono.12411.

Ministry of Education (MOE). (2013). Nurturing early learners: A curriculum for kindergartens in Singapore. *Educators' guide:overview*. Retrieved from source/document/education/preschool/files/nel/edu/guide/overview.pdf

Mielo, E., & Prado, P. (2022). Correlational Analysis Between Approximate Numerical Estimate And Math Abilities: A Study With First-Grade School Students. *Psychological Applications and Trends*. https://doi.org/10.36315/2022inpact015.

NAEYC. (National Association for the Education of Young Children). (2012). *Developmentally Appropriate Practice in Early Childhood Programs Serving Children from Birth through Age 8.National Association for the Education of Young Children position statement*. Retrieved from http://www.naeyc.org/files/naeyc/file/positions/PSDAP.pdf.

Nelwan, M., Friso-van den Bos, I., Vissers, C., & Kroesbergen, E. (2022). The relation between working memory, number sense, and mathematics throughout primary education in children with and without mathematical difficulties. *Child neuropsychology, 28*(2), 143-170.

Noordende, J., Kroesbergen, E., Leseman, P., & Volman, M. (2020). The Role of Non-symbolic and Symbolic Skills in the Development of Early Numerical Cognition from Preschool to Kindergarten Age. *Journal of Cognition and Development*, 22, 68 - 83. https://doi.org/10.1080/15248372.2020.1858835.

Ouyang, X., Yang, Y., Zhang, X., & Zhang, Q. (2021). Longitudinal relations between the approximate number system and symbolic number skills in preschool children.. *Journal of experimental child psychology*, 212, 105254 . https://doi.org/10.1016/j.jecp.2021.105254.

Papic, M., & Mulligan, J. T. (2007). The growth of early mathematical patterning: an intervention study. in Mathematics: Essential Research, Essential Practice, edited by Watson, J. &Beswick, K. (*Proceedings of the 30th annual conference of the Mathematics education Research group of australasia, hobart,* Vol. 2, pp. 591-600). adelaide: MeRga.

Pasnak, R., Kidd, J., Gadzichowski, K., Gallington, D., Schmerold, K., West, H., & Mason, G. (2015). Abstracting Sequences: Reasoning That Is a Key to Academic Achievement. *The Journal of Genetic Psychology*, 176, 171 - 193. https://doi.org/10.1080/00221325.2015.1024198.

Passolunghi, M. C., & Costa, H. M. (2016). Working memory and early numeracy training in preschoolchildren.*Child Neuropsychology, 22*(1), 81–98. https://doi.org/10.1080/09297049.2014.971726

Prihartanta, H., Sutapa, P., Suharjana, S., & Antoni, M. (2022). Sequential Physical Activity Model to Improve Motor Ability in Early Children. *Advances in Health Sciences Research*. https://doi.org/10.2991/ahsr.k.220106.020.

Purpura, D. J. & Reid, E. E. (2016). Mathematics and language: Individual and group differences in mathematical language skills in young children. *Early Childhood Research Quarterly* 36, 259-268. http://dx.doi.org/10.1016/j.ecresq.2015.12.020.

Raudenbush, S., Hernandez, M., Goldin-Meadow, S., Carrazza, C., Foley, A., Leslie, D., Sorkin, J., & Levine, S. (2020). Longitudinally adaptive assessment and instruction increase numerical skills of preschool children. *Proceedings of the National Academy of Sciences of the United States of America*, 117, 27945 - 27953. https://doi.org/10.1073/pnas.2002883117.

Rabindran, R., & Madanagopal, D. (2020). Piaget's theory and stages of cognitive development-An overview. *Scholars Journal of Applied Medical Sciences*, *8*(9), 2152-2157. https://doi.org/10.36347/sjams 2020.v08i09.034.

Salminen, J., Koponen, T., & Tolvanen, A. (2018). Individuality in the Early Number Skill Components Underlying Basic Arithmetic Skills. *Frontiers in Psychology*, 9. https://doi.org/10.3389/fpsyg.2018.01056.

Schwartz, F., Zhang, Y., Chang, H., Karraker, S., Kang, J., & Menon, V. (2021). Neural representational similarity between symbolic and non-symbolic quantities predicts arithmetic skills in childhood but not adolescence.. *Developmental science*. https://doi.org/10.1111/desc.13123.

Seitz, M., & Weinert, S. (2022). Numeracy skills in young children as predictors of mathematical competence.. *The British journal of developmental psychology*. https://doi.org/10.1111/bjdp.12408.

Sella, F., Tressoldi, P., Lucangeli, D., & Zorzi, M. (2016). Training numerical skills with theadaptive videogame "The Number Race": A randomized controlled trial on preschoolers. *Trends in Neuroscience and Education*, *5*(1), 20-29.

Sharifah Norul akmar Syed Zamri & Juliana hj Md yusop. (2011).Competency Level Of Tabika Kemas Children in Early Math. *Proceedings of international Conference on future education in global Challenges,* 19th april 2011, Surabaya Indonesia.

Sokolowski, H., Merkley, R., Kingissepp, S., Vaikuntharajan, P., & Ansari, D. (2021). Children's attention to numerical quantities relates to verbal number knowledge: An introduction to the Build-A-Train task.. *Developmental science*. https://doi.org/10.1111/desc.13211.

Sufa, F. F., & Setiawan, M. H. Y. (2021). The Introduction of Mathematic Concept in Early Childhood Education: HOTS Skill Stimulation. *AWLADY: Jurnal Pendidikan Anak, 7*(2), 148-161.

Stipek, D., & Valentino, R. A. (2015). Early childhood memory and attention as predictors of academic growth trajectories. *Journal of Educational Psychology, 107*(3), 771– 788. https://doi.org/10.1037/edu0000004

Svane, R., Willemsen, M., Bleses, D., Krøjgaard, P., Verner, M., & Nielsen, H. (2023). A systematic literature review of math interventions across educational settings from early childhood education to high school. *Frontiers in Education*. https://doi.org/10.3389/feduc.2023.1229849. Te Whāriki (2017). *Early Childhood Curriculum* https://www.education.govt.nz/assets/Documents/Early-Childhood/ELS-Te-Whariki- Early-Childhood-Curriculum-ENG-Web.pdf

Threlfall, J. (1999). Repeating patterns in the early primary years. in *Patterns in the Teaching and Learning of Mathematics,* edited by orton, a. london: Cassell.

Uttal, D., Scudder, K., & Deloache, J. (1997). Manipulatives as symbols: A new perspective on the use of concrete objects to teach mathematics. *Journal of Applied Developmental Psychology*, 18, 37-54. https://doi.org/10.1016/S0193-3973(97)90013-7.

Watanabe, N. (2019). Attachment play related to Piaget's conservation task with parent. *International Journal of Psychological Studies*, *11*(2), 24-31. https://doi.org/10.5539/ijps.v11n2p24

Watanabe, N. (2017). Acquiring Piaget's conservation concept of numbers, lengths, and liquids as ordinary play. *Journal of Educational and Developmental Psychology*, *7*(1), 210-217. http://doi.org/10.5539/jedp.v7n1p210

Waters, J. (2004). A study of mathematical patterning in early childhood settings. In Mathematics Education for the 3rd Millennium: Towards 2010, edited by Putt, I., Faragher, R. & McLean, M. *Proceedings of the 27th Annual Conference of the Mathematics Education Research Group of Australasi*a. Sydney: MERGA.

Wilkins, J., Woodward, D., & Norton, A. (2020). Children's number sequences as predictors of later mathematical development. *Mathematics Education Research Journal*, 1-28. https://doi.org/10.1007/s13394-020-00317-y.

Xu, F., Spelke, E. S., & Goddard, S. (2005). Number sense in human infants. *Developmental science*, *8*(1), 88-101.