

Mathematics in kindergarten: A literature review

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Abstract

This research examines further the importance of learning mathematics in Kindergarten (TK), identifying effective methods and basic mathematical concepts taught, the challenges faced, and the role of parents in children's mathematics learning. The approach used in this research is a literature review, based on a review of previous research results that are relevant to the theory and practice of mathematics learning in kindergarten. The results of the study show that mathematics is one of the basic foundations in the formation of children's cognitive abilities, especially those related to understanding patterns, shapes and sizes, the concept of numbers, and children's logical thinking abilities. The basic mathematical concepts taught in kindergarten have been arranged and adapted to the child's abilities and developmental stages according to their age, including material about numbers, geometry, patterns, measurement, and data analysis. Learning methods using varied visual aids, play-based approaches, and a variety of games that encourage children's exploration and active interaction are effective alternative learning methods for children. Mathematics learning up to now has had big challenges due to limited learning time, teacher abilities, and children's initial perceptions about mathematics which are still abstract. In practice, creating a supportive environment and involving children in daily activities that contain mathematical elements requires collaboration and active participation from parents. This confirms that the synergy of teachers and parents determines the success of mathematics learning in early childhood.

Keywords

Mathematics learning, Kindergarten, Basic mathematics methods and concepts, Role of parents

Introduction

Cognitive development is one aspect of development possessed by every individual which develops rapidly along with the child's age. Cognitive development in early childhood includes individual and social learning processes, language mastery, emotional and thought regulation, as well as the development of complex intuitive mathematical thinking abilities which begin to develop even before children enter formal education [1]. Previous research shows that the scope of learning in early childhood does not only stop at understanding numbers and counting but has broad

Published:
April 15, 2025

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Selection and Peer-
review under the
responsibility of the 6th
BIS-HSS 2024 Committee

material coverage (number operations, geometry, measurements, and patterns) and simple data analysis [2,3]. Therefore, the process of learning mathematics, needs to be done by looking at the child's focus and interests, the child's active involvement, and determining material that is appropriate to the child's level of ability to provide opportunities for children to learn in a fun and meaningful way so that children have good understanding and skills when facing mathematical challenges at the next level of education [4-7].

Indonesian legislation regulates and establishes early childhood education (PAUD) as a comprehensive part of the national education system with a focus on supporting children's holistic, integrative development. The focus of education on early childhood which does not only prioritize academics but also must develop all aspects of children's development requires teachers to be able to package appropriate learning for children. The learning style of children who learn everything from concrete to abstract is the basis of children's learning styles, where children's enjoyment and interests influence the learning process and knowledge acquisition at school [8]. Doctoroff in his research stated that high interest in learning in children is closely related to general skills and good mathematical skills [9]. This is the basis that education in early childhood should include elements of children's interest in certain things in learning to help children improve their overall development and academic skills as well as mathematics skills in particular [10].

However, although learning mathematics in early childhood is a part of cognitive development and plays a significant role in life, various challenges and difficulties often arise in its implementation. Teacher competence in responding to children's attitudes or learning styles, children's knowledge of mathematical concepts, teaching skills, and children's development are some of the factors in implementing effective mathematics learning [11]. Previous research findings state that almost all children like, enjoy, and have the ability to learn mathematics as early as possible. However, because of unsupportive economic circumstances, there is still a shortage of environmental awareness to identify potential and give learning chances for youngsters [6]. It was discovered, following additional research conducted to address this issue, that greater parental participation, supporting a positive home environment, providing materials using innovative methods, and other approaches to mathematics education include encouraging teachers to actively engage in training to enhance their teaching abilities and utilizing a wider variety of learning resources [12,13].

This article will discuss further and in-depth how early childhood mathematics learning is carried out, especially at the kindergarten level, through a literature review approach, this article will identify factors for the success of mathematics learning, the various methods and strategies used in learning, the role of teachers, curriculum and learning environment support as well as the role of parents in the learning process. Hopefully, this article can provide more description and insight into strategies and good practices for learning mathematics in early childhood.

Method

This article used a literature review, which involves studying and evaluating several relevant literature sources regarding mathematics learning in early childhood. The literature used as study material is obtained from various trusted databases such as Researchgate, Google Scholar, and Semantic Scholar, as well as reference books based on the topic under study. The sources selected include previous and current research on mathematics learning in early childhood. The process of conducting the analysis involves summarizing, comparing, and evaluating the main findings from existing research to provide a comprehensive picture of mathematics learning in early childhood today.

Result and Discussion

Developing critical thinking skills and training children's reasoning as important academic provisions for children in the long term This is in line with findings in previous research. Mathematics education is a critical component of a child's future academic success. [14] Research conducted by Cross, Odiri, and Rusdawati shows that Effective mathematics learning influences the development of children's basic mathematical knowledge, which will support their success in formal schooling [6,15,16]. Odiri emphasized that Fun and contextualized strategies are always used to facilitate an effective learning process, by using educational game tools that help children improve their understanding of the basic mathematical concepts that are taught [15]. Apart from that, play activities and educational games will help strengthen children's understanding because children consciously carry out concrete mathematics practices so that children directly experience the benefits of learning mathematics, as suggested by Souza and Teixeir [17].

Research by Cohrssen also highlights that integrating mathematics in early childhood learning to prepare children to become active and competent individuals in society is one of the most important things [18]. Early mathematics competence plays a great role in predicting achievement of reading skills compared to early literacy [19,20], this further strengthens the argument that mathematics learning in early childhood has a broad impact on children's academic development, the form of support provided for children to understand mathematics is also an effort to break negative perceptions about the essence of existing mathematics learning [21]. According to Dweck's Growth Mindset Theory, fostering self-confidence that effort and practice are one of the efforts to develop abilities which can indirectly help children see mathematics as a fun challenge that can be achieved easily and not an abstract or fixed skill. Thus, mathematics learning that is fun and contextual and based on children's understanding is critical in supporting children's educational success in general in all field.

Mathematics learning is efficient in developing mathematical understanding when the process includes various essential aspects such as logic, numbers, geometry, and simple data analysis [22]. Variations in the use of learning approaches and a concrete-spatial teaching focus in increasing children's understanding have proven to be effective

methods, which is in line with what was conveyed by Jung who pointed out that visual and manipulative approaches are crucial in facilitating mathematics learning in early childhood [23]. The learning model is tiered or adapts to the child's ability level, emphasizing the importance of visual and manipulative approaches to facilitate mathematics learning in early childhood. Clarke proposed the multilevel learning model as an alternative to providing more support in children's learning processes, considering differences in students' abilities and needs [24]. Vygotsky's sociocultural theory states that learning will be more effective when social interactions and the child's initial knowledge are used as a guide in its implementation. This is in line with the idea that learning activities need to be adapted to the child's developmental stage, as well as ensuring that the support provided is appropriate to the child's understanding. This is also reinforced by the results of research conducted by Sarama and Clements (2009) which emphasizes the importance of learning activities using concrete manipulative games and visual aids as a boost to children's early mathematical understanding. Overall, learning activities adjust to the child's background knowledge, and competence and integrate various relevant methods and materials to build a solid foundation for mastery of mathematical concepts. In addition, Mathematics learning can be made more effective by designing an environment that supports children's independent exploration, by providing activities that allow children to interact directly with targeted objects or materials, as expressed by Wang and Jung also found that children who were involved in various activities such as reading, singing, problem-solving, and artistic activities, both at home and at school, showed higher mathematical thinking abilities [23,25,26]. Furthermore, the use of interactive learning applications and assistive objects in learning can increase children's learning incentives, as well as support their mental development, especially in mathematics and science material, as explained by Zaranis. Thus, integrating various contextual learning methods and providing an environment that supports active exploration can significantly increase the effectiveness of mathematics education in early childhood [27].

Previous research shows that early mathematics skills may have a significant impact on later academic achievement, but unfortunately, kindergarten learning often ignores the importance of mathematics in their curriculum [28–30]. Many children enter kindergarten already having basic skills such as counting and shape recognition [31]. Teachers often spend excessive time on this material, thereby hindering the progress of children who have already mastered these skills, risking reducing their motivation and achievement [28]. In addition, many difficulties are found in mathematics material in kindergarten in the reasoning process related to size comparisons, counting strategies, number identification, and working memory [32]. One effort that has proven effective in increasing mathematics readiness is designing learning strategies that are more focused and based on directed exercises, educational games, and interventions that build an understanding of number concepts, such as subsidization and the use of number lines [33]. Therefore, educators need to be more careful in organizing the timing and strategies of mathematics teaching, ensuring that the mathematics education

provided focuses on strengthening basic skills but also leads to a deeper understanding and mastery of advanced mathematics concepts over time [34,35]. This is in line with Piaget's cognitive development theory which states that children's understanding develops gradually, where each new stage builds on the previous stage. This includes understanding mathematics which focuses a lot on a progressive approach in the teaching process. Evaluations of this teaching approach emphasize that paying greater attention to meaningful mathematical conversations and targeted teaching can improve students' overall mathematics achievement and better prepare them for future academic challenges [33].

Previous research highlights the challenges faced when teaching mathematics in kindergarten, where children's early mathematics abilities have an enormous on their future academic development. Freiman suggests that to promote the growth of mathematic competence, and to support the development of mathematical competence, the curriculum at the kindergarten level needs to be constructed to offer rich learning experiences through challenging open-ended tasks, which enable children to explore and build a deep understanding of mathematics [36]. However, in execution, kindergarten teachers face several significant challenges, such as managing the classroom, dealing with parental attitudes, and meeting students' diverse learning needs [37]. In addition, teachers also have difficulty adapting effective teaching methods, integrating various perspectives, and maintaining children's interest in mathematics, especially with limited resources [38]. These findings underscore the need for more diverse and adaptive teaching approaches, as well as the importance of early intervention to support children's mathematical development. In addition, a supportive home environment is also a key factor in overcoming these challenges, because positive parental involvement can strengthen children's learning experiences. This is confirmed in research by Cabrera et al that parental involvement plays an important role in the early childhood education process, especially in supporting children's numeracy skills. Evaluation of these various approaches shows that success in overcoming these challenges requires close collaboration between teachers, parents, and other related parties, as well as a more flexible approach in designing a mathematics curriculum that suits the needs and potential of children in kindergarten.

Previous research confirms the essential role of parents in supporting early childhood mathematics learning, by creating an inspiring home environment and being directly involved in mathematics activities with their children [39]. Parental involvement is proven to have a positive impact on children's mathematical development and academic achievement, as shown by several studies that identify effective strategies such as playing mathematical games, reading picture books containing mathematical content, and connecting mathematics with everyday experiences [39,40]. However, despite its significant impact, many parents lack understanding or knowledge about early childhood mathematics education, often neglecting it compared to language learning [2,41]. to alleviate this, research suggests the importance of interventions that

provide parents with concrete examples of effective ways to maximize children's interest in mathematics, including strategies for overcoming any mathematics anxiety they may feel [2]. In addition, collaboration between parents and educators is crucial to support children's mathematical development and character formation through mathematics education [39,42]. Parental involvement in activities involving mathematics at home, such as cooking or managing money, can enrich children's learning experiences [43]. A study also showed that significant differences in children's initial mathematics knowledge were closely related to the frequency and quality of mathematics-related conversations and activities at home [44]. Therefore, building parents' awareness of the importance of their involvement in mathematics teaching at home and providing relevant resources and training can be an important step to improving children's mathematics readiness when entering formal school.

Conclusion

According to the findings, early childhood mathematics learning influences children's academic success both now and later. Manipulative, interactive, and contextual mathematics mastery can be achieved through game-based activities, such as those using educational game tools, to aid in the development of children's basic mathematical concept competencies, allowing them to understand mathematical concepts more effectively, significantly, and deeply. The research results also show that mastering initial mathematics competencies plays a crucial role in mastering other academic fields in the future.

The implementation of mathematics learning faces numerous challenges, including a learning orientation that remains focused on numbers, subpar teacher competence, and varying levels of student readiness. Furthermore, a lack of parental awareness and involvement makes it increasingly difficult to strengthen basic children's mathematical concepts. There needs to be innovation in collaborating and involving parents in the learning process.

References

1. Hachey, A.C. The Early Childhood Mathematics Education Revolution. *Early Educ. Dev.* **2013**, *24*, 419–430, doi:10.1080/10409289.2012.756223.
2. Ginsburg, H.P.; Lee, J.S.; Boyd, J.S. Mathematics Education for Young Children: What It Is and How to Promote It. *Soc. Policy Rep.* **2008**, *22*, 1–24, doi:10.1002/j.2379-3988.2008.tb00054.x.
3. Clements, D. Mathematics in Early Childhood Learning. *Natl. Counc. Teach. Math.* **2017**.
4. Salomonsen, T. What Does the Research Tell Us about How Children Best Learn Mathematics? *Early Child Dev. Care* **2020**, *190*, 2150–2158, doi:10.1080/03004430.2018.1562447.
5. Björklund, C.; Ahlskog-Björkman, E. Approaches to Teaching in Thematic Work: Early Childhood Teachers' Integration of Mathematics and Art. *Int. J. Early Years Educ.* **2017**, *25*, 98–111, doi:10.1080/09669760.2017.1287061.
6. Cross, C.T.; Woods, T.A.; Schweingruber, H. Mathematics Learning in Early Childhood: Paths toward Excellence and Equity. *Math. Learn. Early Child. Paths Toward Excell. Equity* **2009**, 1–398, doi:10.17226/12519.
7. Clements, D.H.; Lizcano, R.; Sarama, J. Research and Pedagogies for Early Math. *Educ. Sci.* **2023**, Vol. 13, Page 839 **2023**, *13*, 839, doi:10.3390/EDUCSCI13080839.

8. Arikpo, O.U.; Domike, G. Pupils Learning Preferences and Interest Development in Learning. *J. Educ. Pract.* **2015**, *6*, 31–38.
9. Doctoroff, G.L.; Fisher, P.H.; Burrows, B.M.; Edman, M.T. Preschool Children's Interest, Social-Emotional Skills, and Emergent Mathematics Skills. *Psychol. Sch.* **2016**, *53*, 390–403, doi:10.1002/PITS.21912.
10. Kayalar, F. STUDY INTO THE VIEWS OF CLASSROOM TEACHERS UPON INTEREST-BASED LEARNING IN PRIMA. *Int. J. Turkish Lit. Cult. Educ.* **2017**, *6*, 2776–2787, doi:10.7884/TEKE.4053.
11. Dunphy, E. Early Childhood Mathematics Teaching: Challenges, Difficulties and Priorities of Teachers of Young Children in Primary Schools in Ireland. *Int. J. Early Years Educ.* **2009**, *17*, 3–16, doi:10.1080/09669760802699829.
12. Ray, E.M. Discovering Mathematics: The Challenges That Deaf/Hearing-Impaired Children Encounter. **2001**.
13. Sabri, N.B.; Nordin, N.B.; Mohamed, S.B. Exploration of Teaching Methods in the Implementation of Early Mathematics Teaching and Learning (PdP). *Int. J. Acad. Res. Bus. Soc. Sci.* **2023**, *13*, doi:10.6007/IJARBS/V13-I1/15490.
14. Marsetyaningrum, D. SCIENCE LEARNING IN EARLY CHILDHOOD. *Empowerment* **2018**, *7*, 98, doi:10.22460/empowerment.v7i2p98-107.944.
15. Onoshakpokaiye, O. Early Childhood Mathematics: An Insight into Strategies for Developing Young Children Mathematical Skills. *Math. Educ. J.* **2023**, *7*, 16–30, doi:10.22219/mej.v7i1.24534.
16. Rusdawati The Early Childhood Mathematics Learning. **2020**, 107–109, doi:10.2991/ASSEHR.K.200715.021.
17. Souza, A.N. de; Teixeira, V.R.L. A Importância Da Matemática No Desenvolvimento Da Criança Na Educação Infantil / The Importance of Mathematics in Child Development in Early Childhood Education. *ID line. Rev. Psicol.* **2021**, *15*, 816–827, doi:10.14295/IDONLINE.V15I57.3257.
18. Cohrssen, C.; Page, J. Articulating a Rights-Based Argument for Mathematics Teaching and Learning in Early Childhood Education. *Australas. J. Early Child.* **2016**, *41*, 104–108, doi:10.1177/183693911604100313.
19. Szekely, A. Unlocking Young Children's Potential: Governors' Role in Strengthening Early Mathematics Learning. *NGA Cent. Best Pract.* **2014**, 1–13.
20. Claessens, A.; Engel, M. How Important Is Where You Start? Early Mathematics Knowledge and Later School Success. *Teach. Coll. Rec.* **2013**, 115.
21. Clements, D.H.; Sarama, J. Myths of Early Math. *Educ. Sci.* **2018**, *8*, 1–8, doi:10.3390/educsci8020071.
22. Cotič, M.; Felda, D.; Doz, D. The Didactics of Early Mathematics Learning.; University Library in Kragujevac, 2023; pp. 329–342.
23. Jung, E. Examining Differences in Kindergarteners Mathematics Learning: A Closer Look at Instruction, Socioeconomic Status, and Race. *J. Educ. Res.* **2014**, *107*, 429–439, doi:10.1080/00220671.2013.833074.
24. Clarke, B.; Clarke, D.; Cheeseman, J. The Mathematical Knowledge and Understanding Young Children Bring to School. *Math. Educ. Res. J.* **2006**, *18*, 78–102, doi:10.1007/BF03217430.
25. Wang, A.H.; Firmender, J.M.; Power, J.R.; Byrnes, J.P. Understanding the Program Effectiveness of Early Mathematics Interventions for Prekindergarten and Kindergarten Environments: A Meta-Analytic Review. *Early Educ. Dev.* **2016**, *27*, 692–713, doi:10.1080/10409289.2016.1116343.
26. Stramel, J.; Null, N. *Mathematics Methods for Early Childhood*; 2021;
27. Zaranis, N.; Kalogiannakis, M.; Papadakis, S. Using Mobile Devices for Teaching Realistic Mathematics in Kindergarten Education. *Creat. Educ.* **2013**, *04*, 1–10, doi:10.4236/ce.2013.47a1001.
28. Engel, M.; Claessens, A.; Finch, M.A. Teaching Students What They Already Know? The (Mis)Alignment Between Mathematics Instructional Content and Student Knowledge in Kindergarten. *Educ. Eval. Policy Anal.* **2013**, *35*, 157–178, doi:10.3102/0162373712461850.
29. Jordan, N.C.; Kaplan, D.; Ramineni, C.; Locuniak, M.N. Early Math Matters: Kindergarten Number Competence and Later Mathematics Outcomes. *Dev Psychol* **2009**, *45*, 850–867, doi:10.1037/a0014939.
30. DEMIR, M.; DEMIR, M. Mathematics in Early Childhood Education: Awareness, Perspectives, Knowledge. **2022**, doi:10.21203/RS.3.RS-2025203/V1.
31. Jordan, N.C.; Kaplan, D.; Ramineni, C.; Locuniak, M.N. Early Math Matters: Kindergarten Number Competence and Later Mathematics Outcomes. *Dev. Psychol.* **2009**, *45*, 850–867, doi:10.1037/A0014939.
32. Gersten, R.; Jordan, N.C.; Flojo, J.R. Early Identification and Interventions for Students with Mathematics Difficulties. *J. Learn. Disabil.* **2005**, *38*, 293–304, doi:10.1177/00222194050380040301.

33. Newbury, K.; Wooldridge, D.; Peet, S.; Bertelsen, C. From Policy to Practice: Laying the Foundation for Future Math Success.
34. Engel, M.; Claessens, A.; Watts, T.; Farkas, G. Mathematics Content Coverage and Student Learning in Kindergarten. *Educ. Res.* **2016**, *45*, 293–300, doi:10.3102/0013189X16656841.
35. Lee, J.E. Preschool Teachers' Pedagogical Content Knowledge in Mathematics. *Int. J. Early Child.* **2017**, *49*, 229–243, doi:10.1007/S13158-017-0189-1.
36. Freiman, V. Complex and Open-Ended Tasks to Enrich Mathematical Experiences of Kindergarten Students. **2018**, 373–404, doi:10.1007/978-3-319-73156-8_14.
37. LUCERO, N.I. CHALLENGES AND COPING STRATEGIES OF KINDERGARTEN TEACHERS: INPUT TO THE FORMULATION OF A CONTEXTUALIZED TEACHING MODEL. *Cogniz. J. Multidiscip. Stud.* **2023**, *3*, 564–644, doi:10.47760/COGNIZANCE.2023.V03I08.014.
38. Juson, J.A.G.; Cubillas, T.E. Teaching Pre-Reading in Kindergarten: A Focus on Teachers' Pedagogical Skills, Challenges, and Practices. *Int. J. Sci. Res. Publ.* **2024**, *14*, 186–193, doi:10.29322/IJSRP.14.05.2024.P14927.
39. Streit-Lehmann, J. Involving Parents in Games and Picture Books. **2017**, 147–163, doi:10.1007/978-981-10-2553-2_9.
40. Rahmawati, M.S.; Amri, I. The Role of Parents at Mathematics Learning Innovation in Early Education. *Indones. J. Early Child. Educ. Stud.* **2020**, *9*, 40–47, doi:10.15294/IJECES.V9I1.38349.
41. Phillipson, S.; Richards, G.; Sullivan, P. Parental Perceptions of Access to Capitals and Early Mathematical Learning: Some Early Insights from Numeracy@Home Project. In; 2017; pp. 127–145.
42. Husen, S.D.; Mansor, R. Parents Involvement in Improving Character of Children Through Mathematics Learning. *J. Ilm. Peuradeun* **2018**, *6*, 41–50, doi:10.26811/PEURADEUN.V6I1.178.
43. Muir, T. It's in the Bag: Parental Involvement in a Numeracy at-Home Program. <https://doi.org/10.1177/183693911203700205> **2012**, *37*, 27–33, doi:10.1177/183693911203700205.
44. Levine, E.& Math Learning Begins at Home.Pdf 2017.