



# The effectiveness numeracy learning strategies for early grade students in elementary school: a systematic review



Aisya Senja Mustika<sup>a,1,\*</sup>, Riyadi<sup>a,2</sup>, Sandra Bayu Kurniawan<sup>a,3</sup>

<sup>a</sup> Universitas Sebelas Maret, Surakarta, Indonesia

\* corresponding author

## ARTICLE INFO

# ABSTRACT

Received March 14, 2025 Revised April 16, 2025 Accepted May 3, 2025

#### Keywords

Early numeracy, Learning strategies, Elementary school, Independent Curriculum, Systematic literature review The implementation of the Independent Curriculum in 2022 places improving numeracy skills as one of the priority programs for basic education in Indonesia. Early numeracy skills are an important foundation for children's cognitive development and long-term academic success. This study aims to evaluate and identify the most effective early numeracy learning strategies in supporting the strengthening of elementary school students' numeracy skills. The research method used is a systematic literature review with a qualitative-descriptive approach. Data sources were obtained through manual searches of 18 scientific journal articles and 4 conference proceedings published in the last five years. Of the total 22 publications analyzed, six learning strategies were found to be consistently reported as effective: (1) explicit learning through short-term interventions, (2) the use of concrete manipulatives, (3) the use of visual representations, (4) providing corrective feedback, (5) involving parents in the learning process, and (6) game-based learning. The last strategy is the most dominant, mentioned in eight different studies, with variations of digital and traditional games adapted to the local context. The results of this study provide a comprehensive illustration of relevant and implementable approaches in early numeracy learning. These findings contribute to providing an empirical basis for policy makers and educators to design contextual, adaptive, and evidence-based numeracy learning programs.

© © © © @2025 The Author(s) This is an open-access article under the CC–BY-SA license

# **1. Introduction**

The results of the 2021 ANBK obtained data that 2 out of 3 elementary school students in Indonesia have not achieved the minimum numeracy competency score, or only around 30.66% have achieved the minimum score. Meanwhile, PISA 2022 shows that Indonesia is ranked 68th for mathematics out of 73 countries. This condition is the background for the numeracy strengthening program to become one of the main focuses of the Merdeka curriculum [1]. Numeracy is an essential skill that is important for developing problem-solving and critical thinking skills. This skill is not limited to the school environment but is also important in various aspects of everyday life [2]. Effective numeracy learning in early elementary school grades has a crucial role in shaping students' mathematical understanding at the next level of education [3]. In fact, according to [4] early numeracy skills, such as learning to count, recognize numbers, and compare and manipulate quantities, are strong predictors of school-age mathematics learning and performance. However, in the field, elementary school students in Indonesia still face several challenges. From a study conducted by [5] it was obtained that several factors cause the low level of numeracy of Indonesian students, one of them is teacher teaching experience which is related to learning strategies. Meanwhile, according to [6] students have low numeracy skills due to ineffective teacher competence. Reinforced by research conducted by [7], students' numeracy abilities are influenced by various factors, apart from curriculum design and available resources, an equally important factor is learning methods.

Research shows that diverse teaching approaches and comprehensive support are essential in improving students' literacy and numeracy skills, addressing challenges such as the transition from kindergarten to primary school and differences in student ability [8], [9]. One of the most effective strategies for strengthening students' initial numeracy is to implement mathematical concepts in students' daily lives [10]. This study is intended to collect various sources and identify and analyze various numeracy learning strategies that have been proven effective in improving students' abilities in early elementary school classes. By understanding numeracy learning strategies, teachers or related parties can make more appropriate decisions about how to improve the quality of numeracy learning and help students achieve their full potential in numeracy.

## 2. Method

The research method used is a literature review. According to [11]. Literature review is a collection of a topic in research that is summarized from various journals, articles, books, and other supporting documents that are relevant to the issue being discussed. According to [12], the literature review can provide a comprehensive overview of the literature related to the theme/theory/method and synthesize previous research to strengthen the foundation of knowledge. The purpose of the literature review includes identifying, assessing, and synthesizing empirical evidence to answer specific research questions, minimizing bias, and producing more reliable findings [13]. The type of literature review used is SLR or Systematic Literature Review, which is a structured and systematic approach to collecting, assessing, and synthesizing evidence from existing research related to a particular research question [14]. The five steps in conducting a systematic review are (1) formulating questions, (2) identifying relevant work, (3) assessing research quality, (4) summarizing evidence, and (5) interpreting findings [15]. The SLR method attempts to synthesize the work systematically and objectively. This is done by still identifying and reviewing research that does not support the research hypothesis [16]. The steps of research using the systematic literature review method are as follows.

#### 2.1. Research Question

In this study there are several research questions as follows:

RQ1. What are the results of research related to strategies for strengthening early numeracy in elementary school students?

RQ2. What are strategies in strengthening students' early numeracy in elementary schools?

RQ3. What strategies are most used in strengthening students' early numeracy in elementary schools?

RQ1 researchers intend to collect and synthesize information on what strategies have been carried out to strengthen early numeracy. The strategies obtained are very likely to vary, or one strategy has a different impact influenced by internal and external factors. RQ2 researchers intend to find out from the many strategies that have been implemented, which strategy is most widely used. This is intended so that this study can focus more on examining strategies that are considered effective by many teaching practitioners. By knowing the most widely used strategies, RQ3 From the data obtained from the second answer regarding what strategies are most frequently used in strengthening students' early numeracy in elementary schools, we can analyze which strategies are most effective through the most journal support.

#### 2.2. Search process

The search process was carried out by researchers with manuals from various literature, both journals and conference proceedings from 2015 to 2025. The selected journals are trusted journals from Scopus, Semantic Scholar, Web of Science, Crossref, Google Scholar, OpenAlex, and PubMed that have been cited for related research. The journals are presented in Table 1. Of the 40 journals that were successfully reviewed based on the abstract, there were 23 journals that were worthy of being reviewed in more depth. The selected journals and proceedings were also reviewed by three researchers, namely Mustika, Riyadi, and Kurniawan. Mustika coordinated with Riyadi and Kurniawan to determine what research questions were the basis for this study, Mustika collected and synthesized journals and proceedings, while Riyadi and Kurniawan reviewed the journals and proceedings to then determine which journals and proceedings met the inclusion criteria and which ones met the exclusion criteria.

	6
Source	Acronym
AL-ISHLAH	Al-Ishlah
Budapest International Research and Critics in Linguistics and Education	BirLE
Child Development Perspectives	CDP
Curriculum and Teaching	JCT
Educational Psychologis	J. Educ.Psychol.
Educational Technology Research and Development	ETRD
Edumaspul	Edumaspul
European Conference on Games Based Learning	ECGBL
Frontiers in Psychology	FrontPsychol
International Conference on University Teaching and Learning	InCULT
International Journal of Education	Int. J. Educ
International Journal of Research and Scientific Innovation	IJRSI
Journal of Autism and Developmental Disorders	JADD
Journal of Educational Psychology	JEP
Journal Of Teaching And Learning In Elementary Education	JTLEE
Journal on Mathematics Education	JME
Jurnal Intervensi Psikologi	JIP
Learning and Instruction	Learn Inst
Public Library of Science	PLoS ONE
Proceedings of the International Joint Conference on Arts and Humanities	IJCAH
Scandinavian Journal of Educational Research	Scand.J. Educ. Res
SN Social Sciences	SS

## Table 1. Selected journals and conference proceedings

## 2.3. Inclusion and exclusion criteria

All peer-reviewed journals and conference proceedings on strategies for improving early numeracy skills in primary school students published between 2015 and 2025 were included, considering the following criteria (Table 2).

Table 2.	Inclusion	and E	Exclusion	Criteria
----------	-----------	-------	-----------	----------

Criteria	Descriptions
Inclusion	Systematic literature review (SLR) by considering the research questions that have been determined,
	how the search process is carried out, and how to extract data, as well as data presentation. Journals
	and results of proceedings will not necessarily be references for researchers.
	Meta-analysis (MA)
Exclusion	Journals or proceedings obtained without following the specified rules, such as not being related to the
	research question, an unsystematic data search process, and no data extraction.

## 2.4. Quality assessment

To assess the quality of research to be included in the literature review, this study used a narrative synthesis method. Data were extracted in a manner consistent with the questions. Some representative tools such as tables or charts were used to present the distribution of data on learning strategies to strengthen early learners' numeracy skills.

# **3. Results and Discussion**

## 3.1. Research Related To Strategies for Strengthening Early Numeracy

To obtain data regarding what are the results of research related to strategies for strengthening early numeracy in elementary school students, the author collected 23 pieces of literature. Twenty-four journals are international journals and domestic research journals that talk about early-grade numeracy learning strategies in elementary schools. Table 3 is a complete presentation of data extracted from various literature regarding strategies for strengthening numeracy in students in early elementary school classes.

Author and Vear	Journals	Research result
numor unu i cal	Journal of	Numeracy interventions related to counting with 1-to-1 correspondence
Nelson & McMaster, 2019a	Educational Psychology	strategies for 8 weeks or shorter are more effective for students at lower risk for mathematics difficulties [17]
Elliott & Bachman	Tsychology	Parents who have higher confidence and responsibility have a positive
2018		correlation with children's numeracy abilities [18]
Causing et al., 2024	International Journal of Research and Scientific Innovation	Objects around children such as bananas, stones, sticks, and so on have proven effective in increasing children's involvement in understanding matematical concepts [19].
Hj Kamaruddin <i>et al.</i> , 2023	International Conference on University Teaching and Learning (InCULT)	The use of enactive and iconic representations effectively supports elementary school children's learning fractions. While symbolic representation only works on some children [20].
Lopez-Pedersen <i>et al.</i> , 2023a	Scandinavian Journal of Educational Research	The 14-week intervention targeted early numeracy skills in small groups three times a week, demonstrating that early numeracy skills can be trained in low-performing Grade 1 children, but frequent and long-term intervention is needed for positive effects to be sustained [21].
Fyfe et al., 2023	Educational Psychologis	Corrective feedback can be a powerful learning tool for children in early childhood (ages 3-11), improving their performance in literacy, mathematics, and problem-solving [22].
Ching et al, 2019	Learning and Instruction	Concrete representation is more effective in improving children's understanding of the concept of inversion in simple arithmetic than abstract representation [23].
Lee et al, 2020	Educational Technology Research and Development	Tablet-based math game intervention significantly improved early numeracy skills in children, especially in quantity discrimination, addition, and subtraction tasks [24].
Adedigba, 2023	Journal Of Teaching And Learning In Elementary Education	The game method effectively improves numeracy learning in preschool children and increases their interest in numeracy learning [25].
Sinaga & Simarmata, 2020	Budapest International Research and Critics in Linguistics and Education (BirLE)	Constructive play can improve numeracy skills in elementary school. Play is a tool for children to explore their world, from previously unknown to knowing, from previously unable to able. Play is very important for children [26].
Wei et al., 2022	Frontiers in Psychology	Home numeracy practices, including formal instruction and number game activities, have directional effects on early mathematics skills in young Chinese children [27].
Ghazali et al., 2021	Curriculum and Teaching	Preschool children are more likely to use symbolic representations in completing given tasks [28].
Ahmad S, Siller H, 2024	Journal on Mathematics Education	Integrating concrete and virtual teaching aids into fifth-grade mathematics learning resulted in significant improvements in post-test scores [29].
Mutaf-Yıldız <i>et al.</i> , 2020	Frontiers in Psychology	Home numeracy skills have a positive impact on children's math skills, with formal interactions and further research needed to confirm these findings [30].
Girard <i>et al.</i> , 2021	PLOS ONE	Numeracy experiences at home have a positive impact on children's numeracy abilities at school, this will become more visible if stimulated with challenging activities [31].
Bouck et al., 2014	Journal of Autism and Developmental Disorders	Concrete objects that can be manipulated are effective in helping children solve problems involving subtraction. The results will be more accurate and independence will increase with the use of virtual manipulatives [32].
Perini et al, 2023	European Conference on Games Based Learning	Number Express is a digital game designed to facilitate numerical skills in pre- and primary schools, potentially enhancing children's early numeracy skills [33].

 Table 3.
 Research Related to Strategies for Strengthening Early Numeracy

Aisya Senja Mustika et.al (The effectiveness numeracy learning strategies...)

Author and Year	Journals	Research result
Charitaki <i>et al.</i> , 2021	SN Social Sciences	Early numeracy interventions, such as explicit instruction, corrective feedback, CRA, concrete manipulatives, visual representations, and one- on-one instructional settings, are quite effective for children aged 5-8 years [8].
Hariyadi et al., 2024	AL-ISHLAH	Congklak game improves arithmetic skills and learning motivation in elementary school students, with an average increase rate of 28% [34].
Widiya Putri & Dahlan, 2023	Edumaspul	The classic Congklak game effectively improves elementary school students' arithmetic skills [35].
Mutendi & Makamure, 2019	International Journal of Education	Providing more detailed feedback and simpler instructions has been shown to improve children's understanding of numeracy [36].
Rakhmawati <i>et al.,</i> 2020	Proceedings of the International Joint Conference on Arts and Humanities (IJCAH)	It is easier for children to learn to count at an early age through the traditional game of "dragon snakes" which is modified with the number cards provided [37].
Hestyaningsih & Dinar Pratisti, 2021	Jurnal Intervensi Psikologi (JIP)	Traditional dakon games are effective in improving numeracy skills in children with intellectual disabilities [38].

## 3.2. Strategies in Strengthening Students' Early Numeracy

Based on 22 selected articles, researchers found 4 strategies (supported by at least two journals) that are commonly used in strengthening early numeracy skills in elementary school students, summarized in Table 4.

	•
Journal	Strategy
Charitaki et al., 2021; Lopez-Pedersen et al., 2021; Nelson & McMaster, 2019;	Short-term intervention with
Ching et al, 2019	explicit teaching
Ahmad & Siller, 2024; Bouck et al., 2014; Causing et al., 2024	Use of concrete manipulatives
Ghazali et al., 2021; Hj Kamaruddin et al., 2023	Visual representation
Fyfe et al., 2023; Mutendi & Makamure, 2019	Corrective feedback
Adedigba, 2023; Hariyadi et al., 2024; Hestyaningsih & Dinar Pratisti, 2021;	
Perini et al., 2023; Rakhmawati et al., 2020; Sinaga & Simarmata, 2020; Widiya	Games-based learning strategies
Putri & Dahlan, 2023; Lee et al, 2020	
Elliott & Bachman, 2018; Girard et al., 2021; Mutaf-Yıldız et al., 2020; Wei et al,	Family involvement
2022	raining involvement

**Table 4.** Strategies in Strengthening Early Numeracy

## **3.3.** Strategies are Most Used in Strengthening Early Numeracy

From the strategies for strengthening early numeracy in elementary schools, data can be obtained on the most used in strategies based on the amount of journal support obtained, see Table 5.

Nmber of Journals	Strategy	
4	Short-term intervention with explicit teaching	
3	Use of concrete manipulatives	
2	Visual representation	
2	Corrective feedback	
8	Games-based learning strategies	
3	Family involvement	

Table 5. Strategies are most used in Strengthening Early Numeracy

From the literature that has been successfully synthesized, effective ways to improve early numeracy skills in children include short-term interventions with explicit teaching, concrete manipulatives, visual representations, corrective feedback, game-based strategies, and family involvement. Here is a complete review.

• Short-term intervention with explicit teaching: Interventions conducted over a short period with clear instructions and simpler patterns are effective in improving early numeracy skills [8]. The goal of this strategy is repetition which allows students to have more contact with numeracy.

Teachers can do calculations with one-to-one correspondence [17]. For example, children are asked to point to each object in a row and count them sequentially "one, two, three, etc. Instructions must be conveyed clearly so that children can understand what needs to be done. When children learn to string beads, teachers can first invite children to count the number of beads, they are asked to move the beads from one bowl to another. The activity will be more exciting by asking them to group them by color, and then compare them in large numbers. Students not only learn about numbers but also do simple estimation. In line with research conducted by [39], brief interventions with clear instructions can help preschoolers in the transition to elementary school understand numbers and hone their sense of numbers. One crucial factor that needs to be underlined in implementing counting interventions is explicit instructions that are carried out repeatedly in a short time have also proven effective. However, to maintain these counting skills, teachers need to carry out long-term sustainability programs [21].

- Use of concrete manipulatives: The use of concrete objects to develop children's early numeracy such as fruit, rocks, leaves, or other objects around them has been proven to increase children's active involvement in understanding mathematical concepts [19], [20]. Abstract number symbols will be easier for students to grasp with representations of objects around them that they recognize, this helps them to concretize counting activities. In addition to surrounding objects, teachers can also explain abstract mathematical concepts by using learning media such as base four blocks or colored pieces to help represent the concept. In addition to concrete objects that can be touched and felt, through sophisticated technology, students can also be introduced to virtual teaching aids to support counting activities in the classroom. According to [32], the use of these virtual teaching aids can increase student independence. They are more proactive in counting the virtual objects they see and compete with other students to guess the number of objects. Virtual teaching aids also increase student involvement in simple counting activities.
- Visual representation: According to [28] preschool children tend to use symbolic representation in working on their mathematics-related projects. This can be found in elementary school classes in various subjects, the use of representative tools is considered very effective in helping students understand the data presented. Forest deforestation data, for example, will be easier to understand if a picture of the forest deforestation process is shown in the form of a map from year to year rather than just a description. The use of tables or graphs in presenting dengue fever case data, for example, is much more effective and supports students in synthesizing the phenomenon being studied. This is because they are still at the concrete operational stage, so the right visual representation can encourage them to understand the numbers represented. In general, the use of visual representation in numeracy learning is effectively able to improve children's skills in solving problems and their interest in mathematics. The same thing was expressed by [40] that visual representation can improve children's skills in basic arithmetic.
- Corrective feedback: Feedback is an important part of learning, from feedback children can find out what things need to be strengthened or improved. By simplifying the language and providing more detailed feedback, children can improve their understanding of numeracy [36]. This method is also quite effective in improving their performance in solving mathematical problems, especially for children aged 3-11 years [22].
- Games-based learning strategies: Games are one of the most effective ways to develop children's early numeracy [25]. Fun activities influenced by child psychology have made numeracy games widely developed. The literature shows that these numeracy games are very diverse, ranging from traditional ones such as congklak [34], [35], dragon snakes [37], and dakon [38] to digital ones [33]. In the game of congklak or dakon for example, students do not only learn about cardinal numbers, they also learn about multiples and do estimation calculations to win. Not only congklak or snakes and ladders, but other traditional Indonesian games contain a lot of numeracy. In the game of Tapak Gunung, students learn about measurement and geometry, estimate throws, and so on. In the game of Gobak Sodor, students learn about spatial space, measurement, and speed. According to [26], games are a tool for children to have fun exploring the world while seeking knowledge and honing skills. Playing is very valuable and important for their growth and development.

- 63
- Family involvement: The numeracy experience that parents strive for at home turns out to provide provisions that help children learn numeracy at school [30], [31]. Parents who have greater responsibility for children's literacy and numeracy have been proven to have a positive correlation with children's numeracy skills [41]. Parental involvement can be done by having daily numeracy conversations to train children's sensitivity to numbers [42]. Of the six strategies above, by analyzing Table 5 we can see together that game-based numeracy learning has received the most journal support. This strategy can be considered the most widely applied and researched and has been proven to strengthen students' early numeracy.

# 4. Conclusion

From the research results collected and analyzed, information was obtained that strategies that can be used for early grade numeracy learning in elementary schools include; short-term intervention with explicit teaching, use of concrete manipulatives, visual representations, corrective feedback, visual representations, and family involvement. Observing the six strategies, it can be seen that the six are interrelated and complementary. Concrete teaching aids and visual representation tools are strategies to support students in understanding abstract concepts to be more concrete. Short-term intervention strategies will be more optimal if they involve parents so that children's sense of numbers is not only at school but also at home. Corrective feedback needs to be done all the time to provide students with enlightenment and improvement. Game-based learning strategies receive the most support from journals as strategies for strengthening early numeracy skills. Games are the most interesting because of their nature which combines various learning styles at once, both auditory, visual, and kinesthetic, proportionally which is very appropriate for the physical and psychological state of elementary school students. It is hoped that strategies that have been proven to strengthen student numeracy can be applied by teachers, especially early-grade teachers in elementary schools. These findings can also be used by other parties such as curriculum developers and school principals to be tested in the schools they lead.

# Acknowledgment

We would like to thank the Ministry of Education, Culture, Research and Technology through BPI for providing financial, material, and technical support. The support from BPI is very valuable and has enabled me to complete this research. We would also like to thank the mentors, supervisors, and colleagues who have provided guidance, suggestions, or reflective feedback. Their insights and input have been invaluable in strengthening the quality of this research.

#### **Declarations**

Author contribution	:	All authors contributed equally to the main contributor to this
Funding statement	:	paper. All authors read and approved the final paper None of the authors have received any funding or grants from any institution or funding body for the research
Conflict of interest Additional information	: :	The authors declare no conflict of interest No additional information is available for this paper

## References

- Saidatun Nafisah and I. Budiarso, "Training on the Implementation of Project Based Learning (PBL) Based on Literacy at the Elementery School Level," *ABDIMAS J. Pengabdi. Masy.*, vol. 6, no. 4, pp. 4401–4409, Oct. 2023, doi: 10.35568/abdimas.v6i4.3822.
- [2] R. P. Svane, M. M. Willemsen, D. Bleses, P. Krøjgaard, M. Verner, and H. S. Nielsen, "A systematic literature review of math interventions across educational settings from early childhood education to high school," *Front. Educ.*, vol. 8, Dec. 2023, doi: 10.3389/feduc.2023.1229849.
- [3] L. Gerzel-Short and L. Hedin, "Purposeful Use of High-Leverage Practices to Teach Number Sense," Interv. Sch. Clin., vol. 57, no. 3, pp. 163–168, Jan. 2022, doi: 10.1177/10534512211014839.
- [4] K. P. Raghubar and M. A. Barnes, "Early numeracy skills in preschool-aged children: a review of neurocognitive findings and implications for assessment and intervention," *Clin. Neuropsychol.*, vol. 31, no. 2, pp. 329–351, Feb. 2017, doi: 10.1080/13854046.2016.1259387.

- [5] B. Setiawan, I. N. Muharani, M. Z. Arifin, and D. Ardianto, "Problematic numerical literacy in elementary schools: systematic literature review," *Inventa*, vol. 8, no. 1, pp. 55–65, Mar. 2024, doi: 10.36456/inventa.8.1.a8724.
- [6] I. L. Ndakularak *et al.*, "Profil kemampuan numerasi siswa sekolah dasar kelas tinggi di Malumbi Kabupaten Sumba Timur," *Prima Magistra J. Ilm. Kependidikan*, vol. 4, no. 1, pp. 17–27, Jan. 2023, doi: 10.37478/jpm.v4i1.2383.
- T. Macintyre, "59 Numeracy across Learning," in *Scottish Education*, Edinburgh University Press, 2018, pp. 514–520. doi: 10.1515/9781474437851-060
- [8] G. Charitaki, S. Tzivinikou, G. Stefanou, and S.-G. Soulis, "A meta-analytic synthesis of early numeracy interventions for low-performing young children," SN Soc. Sci., vol. 1, no. 5, p. 105, May 2021, doi: 10.1007/s43545-021-00094-w.
- [9] J. E. Fleischner and M. A. Manheimer, "Math Interventions for Students with Learning Disabilities: Myths and Realities," *School Psych. Rev.*, vol. 26, no. 3, pp. 397–413, Sep. 1997, doi: 10.1080/02796015.1997.12085874.
- [10] J. J. SanGiovanni, Daily Routines to Jump-start Math Class, Elementary School: Engage Students, Improve Number Sense, and Practice Reasoning. Corwin Press, 2019.
- [11] J. W. Creswell and J. D. Creswell, *Research design: Qualitative, quantitative, and mixed methods approaches.* Sage publications, 2017.
- [12] J. Paul and A. R. Criado, "The art of writing literature review: What do we know and what do we need to know?," *Int. Bus. Rev.*, vol. 29, no. 4, p. 101717, Aug. 2020, doi: 10.1016/j.ibusrev.2020.101717.
- [13] E. A. Krupinski, "Writing Systematic Reviews of the Literature—It Really Is a Systematic Process!," J. Digit. Imaging, vol. 32, no. 2, pp. 199–200, Apr. 2019, doi: 10.1007/s10278-018-00176-x.
- [14] Y. Xiao and M. Watson, "Guidance on Conducting a Systematic Literature Review," J. Plan. Educ. Res., vol. 39, no. 1, pp. 93–112, Mar. 2019, doi: 10.1177/0739456X17723971.
- [15] C. Arvanitis, "Systematic literature review in five steps," J. Acoust. Soc. Am., vol. 155, no. 3\_Supplement, pp. A103–A103, Mar. 2024, doi: 10.1121/10.0026958.
- [16] B. Kitchenham, "Procedures for performing systematic reviews," *Keele, UK, Keele Univ.*, vol. 33, no. 2004, pp. 1–26, 2004.
- [17] G. Nelson and K. L. McMaster, "The effects of early numeracy interventions for students in preschool and early elementary: A meta-analysis.," *J. Educ. Psychol.*, vol. 111, no. 6, pp. 1001–1022, Aug. 2019, doi: 10.1037/edu0000334.
- [18] L. Elliott and H. J. Bachman, "How Do Parents Foster Young Children's Math Skills?," Child Dev. Perspect., vol. 12, no. 1, pp. 16–21, Mar. 2018, doi: 10.1111/cdep.12249.
- [19] R. A. Causing, A. G. Araquil, L. K. G. O. Baldove, and R. H. Toreno, "Enhancing Numeracy Skills for Learners at the Margin Utilizing Concrete Manipulatives: A Community-Based Participatory Action Research," *Int. J. Res. Sci. Innov.*, vol. XI, no. VII, pp. 1074–1085, 2024, doi: 10.51244/IJRSI.2024.1107085.
- [20] N. I. Hj Kamaruddin, J. B. Zik Hong, and T. S. Hoon, "Pupils' Representation in Learning Fractions: Qualitative Findings," in 2023 International Conference on University Teaching and Learning (InCULT), 2023, pp. 1–6, doi: 10.1109/InCULT59088.2023.10482630.
- [21] A. Lopez-Pedersen, R. Mononen, P. Aunio, R. Scherer, and M. Melby-Lervåg, "Improving Numeracy Skills in First Graders with Low Performance in Early Numeracy: A Randomized Controlled Trial," *Remedial Spec. Educ.*, vol. 44, no. 2, pp. 126–136, Apr. 2023, doi: 10.1177/07419325221102537.
- [22] E. R. Fyfe, G. A. Borriello, and M. Merrick, "A developmental perspective on feedback: How corrective feedback influences children's literacy, mathematics, and problem solving," *Educ. Psychol.*, vol. 58, no. 3, pp. 130–145, Jul. 2023, doi: 10.1080/00461520.2022.2108426.
- [23] B. H.-H. Ching and X. Wu, "Concreteness fading fosters children's understanding of the inversion concept in addition and subtraction," *Learn. Instr.*, vol. 61, pp. 148–159, Jun. 2019, doi: 10.1016/j.learninstruc.2018.10.006.

- [24] H. K. Lee and A. Choi, "Enhancing early numeracy skills with a tablet-based math game intervention: a study in Tanzania," *Educ. Technol. Res. Dev.*, vol. 68, no. 6, pp. 3567–3585, Dec. 2020, doi: 10.1007/s11423-020-09808-y.
- [25] O. Adedigba, "Enhancing numeracy instruction through games in pre-primary classrooms," J. Teach. Learn. Elem. Educ., vol. 6, no. 1, p. 96, Jun. 2023, doi: 10.33578/jtlee.v6i1.7984.
- [26] R. Sinaga and E. J. Simarmata, "Constructive Play on Numeracy Skills in Elementary School," Budapest Int. Res. Critics Linguist. Educ. J., vol. 3, no. 4, pp. 1644–1650, Oct. 2020, doi: 10.33258/birle.v3i4.1301.
- [27] W. Wei, Q.-Y. Wang, Q. Luo, and Y. Li, "Cross-lagged relationship between home numeracy practices and early mathematical skills among Chinese young children," *Front. Psychol.*, vol. 13, Dec. 2022, doi: 10.3389/fpsyg.2022.1033065.
- [28] M. Ghazali, Z. Ismail, Z. M. Ashari, and Z. Mustafa, "The Representation Strategies of Preschool Children When Solving Numeracy Task," *Curric. Teach.*, vol. 36, no. 2, pp. 87–101, Dec. 2021, doi: 10.7459/ct/36.2.07.
- [29] S. Ahmad and H.-S. Siller, "Investigating the effect of manipulatives on mathematics achievement: The role of concrete and virtual manipulatives for diverse achievement level groups," *J. Math. Educ.*, vol. 15, no. 3, pp. 979–1002, Sep. 2024, doi: 10.22342/jme.v15i3.pp979-1002.
- [30] B. Mutaf-Yıldız, D. Sasanguie, B. De Smedt, and B. Reynvoet, "Probing the Relationship Between Home Numeracy and Children's Mathematical Skills: A Systematic Review," *Front. Psychol.*, vol. 11, Sep. 2020, doi: 10.3389/fpsyg.2020.02074.
- [31] C. Girard, T. Bastelica, J. Léone, J. Epinat-Duclos, L. Longo, and J. Prado, "The relation between home numeracy practices and a variety of math skills in elementary school children," *PLoS One*, vol. 16, no. 9, p. e0255400, Sep. 2021, doi: 10.1371/journal.pone.0255400.
- [32] E. C. Bouck, R. Satsangi, T. T. Doughty, and W. T. Courtney, "Virtual and Concrete Manipulatives: A Comparison of Approaches for Solving Mathematics Problems for Students with Autism Spectrum Disorder," J. Autism Dev. Disord., vol. 44, no. 1, pp. 180–193, Jan. 2014, doi: 10.1007/s10803-013-1863-2.
- [33] N. Perini, A. Porru, K. Moeller, T. Jay, and F. Sella, "Number Express: a Digital Game to Improve Early Numeracy," *Eur. Conf. Games Based Learn.*, vol. 17, no. 1, pp. 515–522, Sep. 2023, doi: 10.34190/ecgbl.17.1.1430.
- [34] A. Hariyadi, A. Rasyad, W. Rondhi S, D. Santoso N, and F. Najikhah, "Enhancing Numeracy Skills in Elementary Students through the Traditional Congklak Game: A Study in Kudus," *AL-ISHLAH J. Pendidik.*, vol. 16, no. 3, Sep. 2024, doi: 10.35445/alishlah.v16i3.5613.
- [35] F. Widiya Putri and Z. Dahlan, "Effectiveness of Using the Congklak Game in Improving the Numeracy Skills of Grade 1 Elementary School/MI Students," *Edumaspul J. Pendidik.*, vol. 7, no. 2, pp. 5347–5356, Oct. 2023, doi: 10.33487/edumaspul.v7i2.7241.
- [36] M. Mutendi and C. Makamure, "The Role of Written Feedback in Numeracy in the Primary School Classroom," Int. J. Educ., vol. 11, no. 2, p. 52, May 2019, doi: 10.5296/ije.v11i2.14550.
- [37] N. I. S. Rakhmawati, R. Hasibuan, and I. Sholichah, "Developing Children's Early Numeracy Skill Through Traditional Game 'Dragon Snakes," in *Proceedings of the International Joint Conference on Arts and Humanities (IJCAH 2020)*, 2020, doi: 10.2991/assehr.k.201201.043.
- [38] L. Hestyaningsih and W. Dinar Pratisti, "Efektivitas Permainan Tradisional Dakon untuk Meningkatkan Kemampuan Berhitung pada Anak Tunagrahita," J. Interv. Psikol., vol. 13, no. 2, pp. 161–174, Nov. 2021, doi: 10.20885/intervensipsikologi.vol13.iss2.art7.
- [39] C. Sophian, "Early Developments in Children's Understanding of Number: Inferences about Numerosity and One-to-One Correspondence," *Child Dev.*, vol. 59, no. 5, pp. 1397–1414, Oct. 1988, doi: 10.1111/j.1467-8624.1988.tb01508.x.
- [40] M. M. Zainudin and A. F. Zainudin, "The Use of Representations in Supporting Early Mathematics Learning and Problem Solving," Int. J. Acad. Res. Progress. Educ. Dev., vol. 12, no. 2, Jun. 2023, doi: 10.6007/IJARPED/v12-i2/17352.

- [41] L. Elliott, P. Zheng, and M. Libertus, "Individual Differences in Parental Support for Numeracy and Literacy in Early Childhood," *Educ. Sci.*, vol. 11, no. 9, p. 541, Sep. 2021, doi: 10.3390/educsci11090541.
- [42] E. A. Gunderson and S. C. Levine, "Some types of parent number talk count more than others: relations between parents' input and children's cardinal-number knowledge," *Dev. Sci.*, vol. 14, no. 5, pp. 1021– 1032, Sep. 2011, doi: 10.1111/j.1467-7687.2011.01050.x.