



Exploring Early Childhood Counting Principles

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Abstract. The Gap between parents' desire for their children to have early numeracy skills and that children need to learn counting according to appropriate early counting principles based on Local Culture gives rise to several issues in early childhood counting principles. Examining the urgency of introducing the correct concept of early counting is essential. This study aims to explore various research findings on early childhood counting principles based on the local culture of South Sumatra. The research method used is a literature review of primary sources. The literature review findings indicate nine principles of early counting: (1) the One-to-one correspondence principle, (2) the principle of counting in a stable sequence, (3) the Cardinality principle, (4) the principle of counting in an irrelevant order, (5) Abstract counting principle, (6) Memorization and rational counting principle, (7) Principle of counting using daily concepts based on Local Culture, (8) Problem-oriented counting principle, (9) Repetition counting. This research provides new insights by examining information on these nine principles derived from 52 recent research studies from 2020 until 2023. The impact is that teachers can focus on stimulating early numeracy skills in young children according to the principles of early counting. In conclusion, learning to count based on the principles of early counting indicates success in early numeracy learning.

Keywords: Early Childhood Mathematics, Counting Principles, Literature Review

1 Introduction

Counting is the foundation of many sciences used in daily life, and mathematics plays an important role in every activity. Considering the importance of counting skills for humans, it is crucial to teach counting activities from an early age using various appropriate media and methods that do not interfere with other aspects of a child's development.

Counting skills are extremely important for children as they provide a strong foundation for understanding number concepts and the ability to solve mathematical problems in daily life. With counting skills, children can effectively perform basic mathematical operations such as addition, subtraction, multiplication, and division. Counting

skills also enable children to measure, compare, and classify objects and quantities around them. For example, they can count the items purchased at a store, measure time, divide food into equal groups, or estimate the money needed to buy something. Counting skills also help children understand patterns, relationships, and more complex mathematical principles. By utilizing counting skills, they can apply mathematical concepts in real-life situations, such as counting, estimating quantities, or solving problems in daily life.

Children can develop problem-solving skills, logic, and critical thinking by applying counting skills in real-life contexts. They learn to identify problems, formulate strategies, seek alternative solutions, and evaluate the solutions' effectiveness. Therefore, counting skills are not just about counting numbers but also about understanding mathematical concepts more broadly and applying them in daily life. Through good teaching and appropriate support, strong counting skills give children the confidence and abilities to tackle mathematical challenges and problems.

Relevant research on the importance of counting skills includes [1], which states that counting skills are the ability of children to understand number concepts, enabling them to apply and solve mathematical problems in daily life. Another study conducted by [2] indicates that using linear number line games can enhance children's counting knowledge and arithmetic skills. Early childhood learning of counting knowledge impacts children's future mathematical learning abilities. By employing this approach, children are expected to develop a better understanding of numbers and establish a strong foundation in mathematics for the future. Similarly, according to [3], this research provides crucial insights for educators and policymakers in designing effective pre-school education programs to develop early counting skills in children. With a better understanding of the influencing factors, educational programs can be tailored to help children achieve optimal counting abilities before entering formal schooling. Another study conducted by [4] demonstrates that using fingers in solving addition problems indicates that kindergarten children who are most proficient in counting with their fingers tend to abandon this strategy by Grade 2. Furthermore, research conducted by [5] reveals that mathematics education in schools has been a focus of attention for years, with efforts to address the issues and improve the quality of teaching and learning mathematics, including curriculum reforms that shift from a content-centered curriculum approach to a learning outcome-based curriculum, aiming to transition from teacher-centered to more student-centered instructional approaches.

Other research findings indicate that even from early childhood, individuals understand that counting usage reflects the motivation to achieve accuracy and fairness. They utilize counting to evaluate others' behavior in the context of fairness, considering various factors in decision-making and providing outcomes they perceive as fair based on counting. This research provides insights into how children understand fairness and counting in social contexts [6]. Another study reveals that children often make mistakes in counting; therefore, it is important to provide appropriate learning experiences and introduce more abstract counting concepts to help overcome potential counting errors and strengthen their holistic understanding of counting concepts [7]. Additionally, research by [8] offers a deep understanding of the importance of devel-

oping executive functions and counting skills in early childhood. The implication is the significance of supporting children's executive function development and providing opportunities for them to acquire strong counting skills. One way to enhance children's counting abilities is by modifying textbooks given to young children, providing numerous engaging pictures and colors to make learning more appealing and facilitate their understanding of number recognition [9]. Children's interest in mathematics can be stimulated through the game "Math Wizard Magical Workshop's Potions" from Osmo [10]. Other research also indicates the need for more conceptual tools to advance thinking about mathematical learning with children's books, an area lacking research and practice [11].

Unlike previous research, this study brings a novelty that has not been discussed. The novelty of this research includes: (1) This study focuses on providing information about the principles of early counting for young children and facilitating teachers in formulating stimulation for early counting abilities in young children. (2) Unlike previous research methods on similar topics, this study utilizes a qualitative method through a literature review. (3) The literature reviewed in this study consists of 52 research journals from the past four years, from 2020 to 2023, focusing on the principles of early counting.

Learning for Young children should adopt the principle of learning through play because counting plays a crucial role in their cognitive development and is a relevant mathematical concept for their age. Play activities allow children to learn fun and naturally, engaging and motivating them in the learning process. In addition to the principle of learning through play, there are six other recommended principles based on the literature review, namely: (1) One to One Correspondence principle, (2) the Stable sequential counting principle, (3) the Cardinality principle, (4) Irrelevant order counting principle, (5) Abstract counting principle, (6) Memorization and rational counting principle, (7) Counting principle using daily life concepts for children, (8) Problem-solving oriented counting principle, (9) Repetition counting principle. By adopting these principles in early childhood counting learning, we can create enjoyable, meaningful, and effective experiences for them. Positive and enjoyable learning experiences in early childhood will help build a strong foundation for a deeper understanding of mathematics in the future.

2 Method

The research used a qualitative research design with a literature review approach. This method was chosen to examine 52 relevant literature sources related to the research objectives. The literature review approach involved collecting information from primary sources, specifically, journals published in the past four years and distributed across four continents. The data collection method involved searching keywords on five journal search platforms: ScienceDirect, ResearchGate, Tandfonline, Wiley & Sons, and Google Scholar. The researcher only cited relevant references aligned with "exploring counting principles for young children" from 2020 to 2023. The data collection took place over three months,

from April to June. The data analysis technique employed in this research follows the Miles & Huberman analysis technique: (1) selecting data, (2) displaying data, and (3) verifying data. The research process flow can be illustrated in Figure 1.

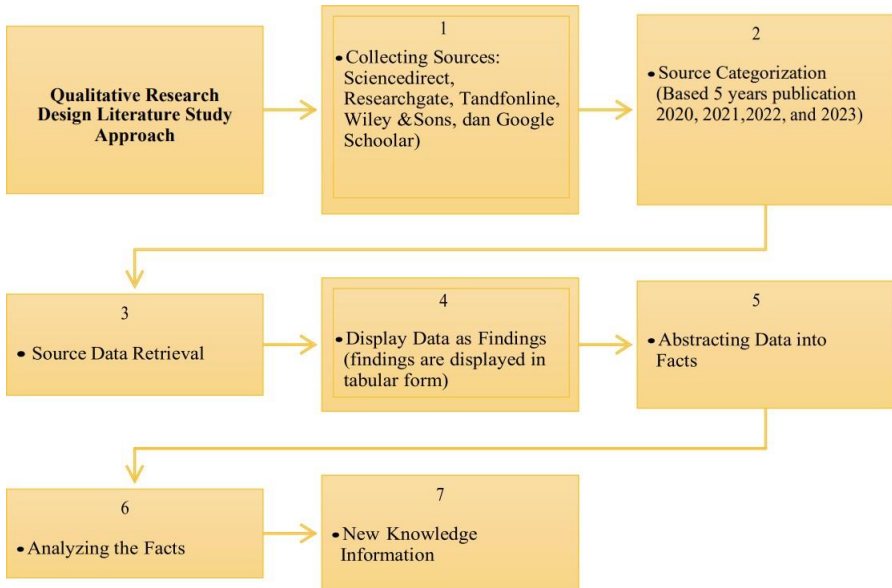


Fig. 1. Research Flow

3 Result and Discuss

The research findings are based on a literature study approach. The content analysis was derived from primary sources, specifically research journals categorized by publication year from 2020 to 2023. The research result is depicted in Figure 2.

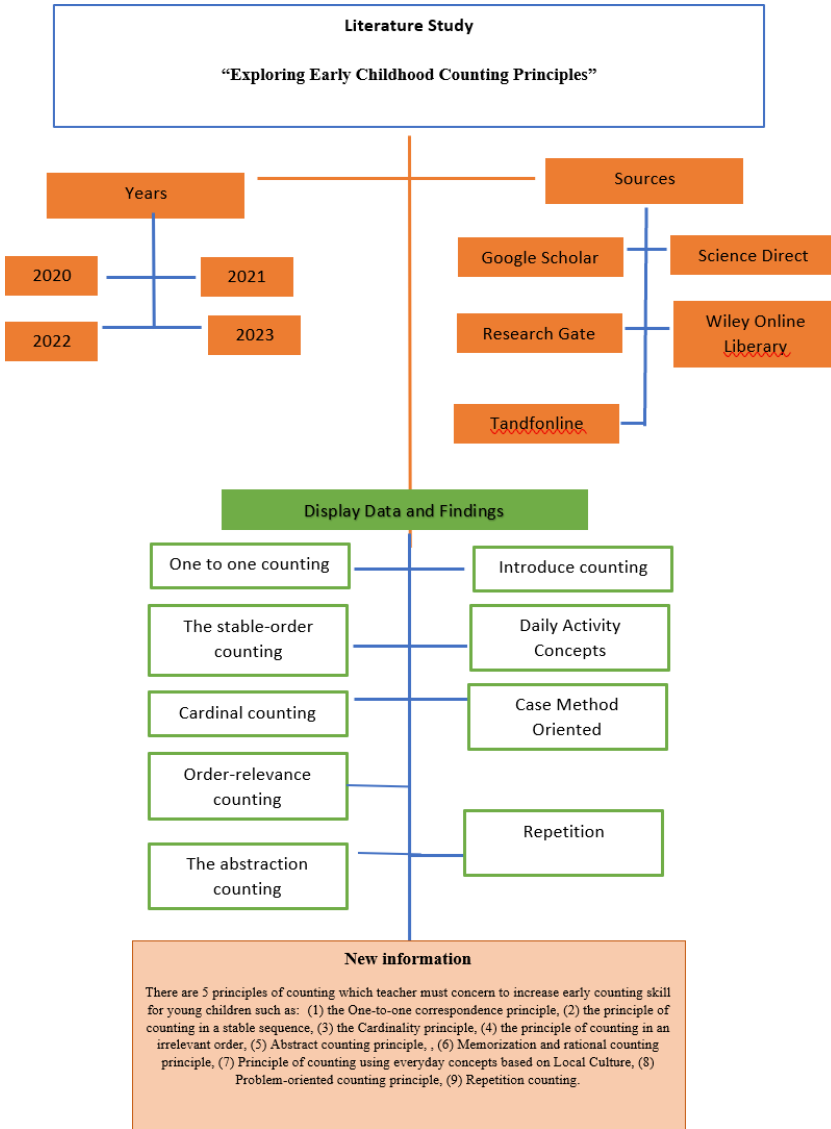


Fig. 2. Research Result

The diagram illustrates the researcher's findings from analyzing the 52 literature sources. These sources were obtained from the five journal search platforms: Google Scholar, ScienceDirect, ResearchGate, Wiley Online Library, and Taylor & Francis Online. The search was conducted by accessing these platforms for two months. Furthermore, the journals reviewed were those published in the past four years, from 2020 to 2023. The reason for selecting these four periods is that the researcher intended to review the most recent literature. The literature reviewed was relevant to the topic of "title." For a more comprehensive illustration, please refer to Figure 3 below.

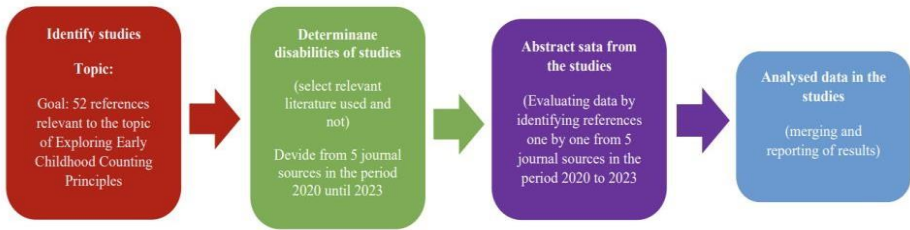


Fig. 3. Implementation of Systematic Review

The implementation of the literature analysis process was conducted through a systematic review. This process consists of four stages: (1) Identity Studies: This is the first stage, where the researcher determines the topic and objectives of the study. The topic examined in this research is "stimulating children's skills before they are ready to write," while the objective is to review 52 relevant literature sources related to the research topic. (2) Determine the Suitability of Studies: This stage involves sorting and selecting the relevant and applicable literature. The researcher decides which literature sources will be used and which will not. The selected literature is obtained from five journal sources from 2020 to 2023. This process is done by accessing relevant keywords on journal platforms such as ScienceDirect, ResearchGate, Taylor & Francis Online, Wiley & Sons, and Google Scholar. The researcher sets the period to include journals published in the last four years, from 2020 to 2023.

Abstract Data from the Studies: In this stage, the researcher identifies and abstracts each of the 52 journal articles obtained from the search conducted on the five journal sources over the past four years. The researcher creates a table to facilitate data abstraction from each journal article. The criteria for identification in each journal article include the source of the journal, publisher, country, year, and research findings. Once the 52 journals are identified based on the predetermined criteria, the researcher examines the relevance of each research finding to the topic. The results of data abstraction regarding the number of journal sources reviewed in the past four years can be illustrated in Figure 4.

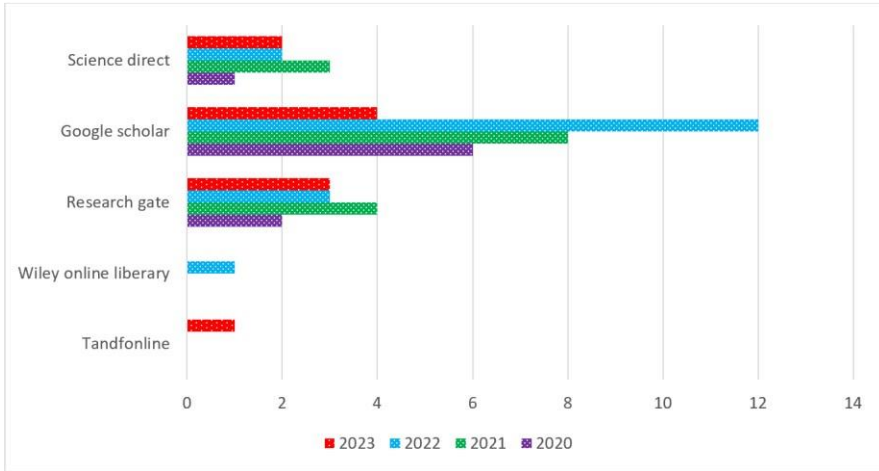


Fig. 4. Journal Sources from 2020 until 2023

The number of articles accessed from the "ScienceDirect" journal search page was 8: 1 article in 2020, 3 articles in 2021, 2 articles in 2022, and 2 articles in 2023. Furthermore, 12 articles

were accessed from the "ResearchGate" page: 2 articles in 2020, 4 articles in 2021, 3 articles in 2022, and 3 articles in 2023. As for the "Taylor & Francis Online" page, one article was accessed in 2023. One article was accessed from the "Wiley & Sons" journal search page, published in 2022. Meanwhile, from the "Google Scholar" page, 30 articles were accessed, including six articles in 2020, 8 in 2021, 12 in 2022, and 4 in 2023. Figure 4 shows that the most dominant articles were accessed from Google Scholar and ResearchGate, followed by ScienceDirect. In contrast, the fewest articles were sourced from Taylor & Francis Online and Wiley Online Library.

In addition, the abstracted data from the 52 reviewed journals from various countries were categorized into four continents: Asia, Europe, America, and Africa. This pie chart shows the percentage of journals reviewed in each continent. 63% of the reviewed journals from 2020 to 2023 originated from Asia, including Indonesia, India, Singapore, Israel, and Uzbekistan. 25% originated from Europe, including the UK, Turkey, Germany, and Sweden. 6% originated from America, including the USA. 6% originated from Africa, including countries such as Zimbabwe and Spain. The percentage data of literature sources from each continent in the last four years can be seen in Figure 5.

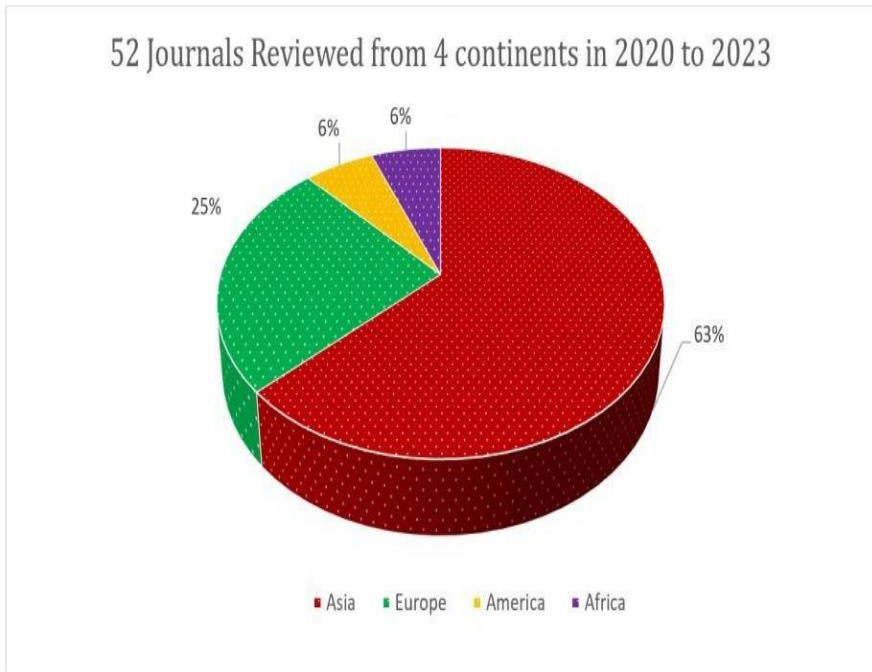


Fig. 5. Percentages of Literature Sources from four Continents

(4) Analyzed data in the studies: The fourth stage analyzes the data abstracted in the previous stage. This stage involves analyzing the research findings from the 52 articles reviewed from the five journal article search sources in the past four years, then assessing their relevance to early childhood counting principles. The analysis is conducted by identifying the findings of each article through a detailed examination of the results, discussion, and conclusion sections. Subsequently, the overall findings regarding the various principles of counting ability in early childhood are summarized. The results of this research data analysis can be illustrated in Table 1.

Table 1. Table Analysis

| No | Sources | 2020 | 2021 | 2022 | 2023 |
|----|---------|------|------|------|------|
|----|---------|------|------|------|------|

| | | | | | |
|----|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. | Google Scholar | Rote counting and rational counting, teaching cardinal counting principles, teaching order-relevance counting principles, and problem-oriented counting principles | Teaching one-to-one counting principles, teaching stable-order counting principles, Rote counting, rational counting, teaching cardinal counting principles, teaching order-relevance counting principles, teaching abstraction counting principles, the principle of count- | Teaching one-to-one counting principles, teaching stable-order counting principles, Rote counting, rational counting, teaching cardinal counting principles, teaching order-relevance counting | Teaching abstraction counting principles principle of counting using daily concepts based on Local Culture, Principle of counting using daily concepts based on Local Culture, and repetition counting principles |
| 2. | Science Direct | Teaching cardinal counting | Rote counting and rational counting, | ing using daily concepts based on Local Culture, and problem-oriented counting principles principles, teaching abstraction counting principles, the principle of counting using daily concepts based on Local Culture, and repetition counting principles teaching stable-order counting | Teaching one-to-one counting principles, |

| | | | | | |
|----|------------------------------|-----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| | | principles | teaching or- der- relevance counting prin- ciples | principles, Teaching cardinal counting principles, and teaching order- relevance counting principles | teaching and Teaching cardinal counting prin- ciples |
| 3. | Research gate | Teaching cardinal counting principles and teaching order- relevance counting principles | Rote count- ing and ra- tional counting and teaching the abstraction counting prin- ciples | Teaching one-to-one counting principles, teaching, Teaching cardinal counting principles, the principle of counting using daily concepts based on Local Cul- ture, and problem- oriented counting principle | Teaching cardinal counting prin- ciples and problem- oriented counting prin- ciples |
| 4. | Wiley online li- brary | | | Rote count- ing and ra- tional count- ing | |
| 5. | Tandfonline | | | | Teach- ing car- dinal counting prin- ciples |

Based on the data analysis, this research identified nine initial counting principles, including (1) One to One Correspondence Counting Principle, (2) Stable Sequential Counting Principle, (3) Cardinality Principle, (4) Counting with Irrelevant Order Principle, (5) Abstract Counting Principle, (6) Counting with Memorization and Rationality Principle, (7) Counting Using Daily Concepts Based on Local Culture Principle, (8) Problem-Oriented Counting Principle, and (9) Repetition Counting Principle. These nine principles indicate children's readiness in early counting activities. Teaching *the one-to-one counting principle is fundamental in counting*. The principle works by counting each object once and only once. Two important abilities are used in this principle: matching numbers with objects and separating counted objects from objects to be counted. Common mistakes include skipping an object entirely and counting the same object twice [12]. For children to count objects correctly, they need to see them and understand that each number in the counting sequence must correspond to one and only one object [13]. When young children have number sensitivity, including developing their counting skills, they will understand that numbers correspond one to one [14]. One-to-one counting involves sequentially reciting numbers' names without skipping any objects. Children understand the one-to-one correspondence counting principle well at age five, which improves as they get older [15]. *Teaching the stable-order counting principles* involves the child's ability to count a collection of objects repeatedly and associate the appropriate and stable number words. The counting sequence must be repeatable to acquire this principle, meaning the number of words should follow a stable and interconnected order. Young children learn to count each object only once in a stable order, and the last number in the sequence indicates the number of objects [16]. Early childhood counting is sequential and stable, where the counted numbers are interconnected, and the last number mentioned represents the final count [17]. The stable-counting principle essentially refers to verbal counting, where number words are conventionally pronounced sequentially and consistently [18]. The child's ability to recite numbers is crucial for counting objects. Counting refers to objects to express the number of objects being counted.

Teaching Cardinal Counting Principles is a conceptual foundation for meaningful counting and provides a basis for understanding other key aspects of counting. This finding emphasizes the importance of educators and parents in building children's abilities to understand and apply cardinality principles [19]. The cardinality principle states that the last number uttered reflects the overall quantity of the set being counted [20]. Research on the emergence of alternative counting principles, especially cardinality, has made significant progress in understanding the conceptualization of numbers in children's development [21]. Counting and understanding cardinality is crucial in children's numerical development [22]. Children learn to recognize the cardinality of the first few numbers, such as one, two, three, and four, before they learn how to count the cardinality for all numbers. As they begin to grasp the concept of counting, they also discover the structure of the number system [23].

The cardinality principle refers to a child's understanding that the total quantity of objects in a set can be represented by a number, known as a cardinal number. The cardinality principle is important in early numerical development [24]. Children's

understanding of number names expands their conceptual understanding to include groups of tens, linking the two number words in 18 (eighteen) to the numbers ten and eight with their numerical symbol 18 [25]. Acquiring cardinal numbers or understanding the relationship between numbers and quantity underlying the cardinality principle is a significant milestone in developing early numerical skills and better mathematical abilities in children [26]. The cardinality principle states that the last number a child counts represents the total quantity of objects in the set being counted [27]. Children's early numeracy and arithmetic skills can vary greatly, with each child having a unique developmental level and gradual numerical understanding over time [28].

Teaching Order-Relevance Counting Principles states that the result of counting remains the same, regardless of the starting point used, unless the counting rules are violated [29]. The principle of order relevance states that objects can be counted in any order. Therefore, children's development should be based on their thinking ability [30]. Activities that introduce aspects of abstract visual features, such as irrelevant colors in counting a set of objects, can be beneficial [31]. Once children are familiar with verbal and object-counting activities, they are ready to be given stimuli to enhance their number sensitivity [32]. One game that can stimulate counting skills is puzzled, which can support children's development while training logic, and spatial abilities, stimulating the brain, and fostering imagination [33]. Other research on the principle of order relevance in children's development of numerical skills suggests that the order of counting objects does not affect the overall quantity. For example, using a number tree in learning, this game teaches children that the order of counting objects on the number tree does not affect the overall quantity [34].

Teaching the abstraction counting principles, as children develop their ability to recognize different hypotheses, they also enhance their intuitive abstraction abilities and reorganize previously built mathematical knowledge into new structures [35]. This principle typically indexes the level of abstraction by counting the number of abstract utterances [36]. Numbers are basic mathematical concepts that contain abstractions of high-level generalizations and abstractions of their foundational constructions that can be sensed perceptually [37]. Representation is important because numbers are abstract and thus must be represented in multiple ways in all situations to be communicative [38].

Teaching Counting Principles with Memorization and Reasoning. Pre-school children have good skills in "counting rhythmically, stable sequencing, counting the next numbers, abstraction, cardinal numbers, and recognizing numbers." They do not encounter difficulties in these aspects [39]. Early childhood mathematics education aims to teach logical and mathematical thinking in a fun and uncomplicated way. Principles of early childhood counting include making lessons enjoyable, directly involving children, building their desire and confidence in adapting to counting, appreciating children's mistakes without punishing them, and focusing on their achievements [40]. The principle of counting with memorization and reasoning can be applied in tasks such as counting 20 fish lined up linearly with the highest score for correct counting. In this task, children are asked to count rationally by understanding the concept of quantity and stable order in counting [41]. Introducing mathematics to

young children can be done through various learning media, including online learning. Studies show that educational games can provide children with interactive and enjoyable learning experiences [42].

Additionally, the principle of counting with memorization in mathematics education can be implemented through music-based learning, as music can help children remember information effectively, including mathematical concepts and number sequences [43]. Another supportive research concluded that the traditional game of Dakon is effective as a means to develop counting skills in children [44]. It is necessary to enhance adults' knowledge about the importance of promoting verbal counting, regardless of object-based counting, and increase adults' awareness of number composition and decomposition [45]. The student-centered approach was used. The first longitudinal study investigated several component numerical skills in the preschool population. This approach allows for investigating subgroup learning paths with different mathematical abilities over time [46].

They were counting Principles using Daily Concepts based on Local Culture. Counting principles based on local culture that incorporate traditional games into learning activities have important benefits for children. By combining local culture and traditional games in counting education, children can experience play activities related to their cultural heritage [47]. Research reveals the positive benefits of using the snake and ladder game as a medium for counting principles based on local culture in the learning process. Using the snake and ladder game in learning can create enjoyable conditions for children [48]. Another similar opinion is that implementing culturally-based learning media, such as playing Congklak Games, for introducing number concepts to 5-6-year-old children has positive potential in improving counting skills. The research results show that this culturally-based educational game can help children better understand number concepts. In addition to introducing children to number concepts, the game also introduces them to their rich local cultural heritage. These games can increase children's interest in mathematics and strengthen their connection with their culture [49]. Counting principles using simple concepts based on local culture (ethnomathematics) are present in some traditional indigenous knowledge systems. These elements related to early childhood include counting concepts (addition and subtraction), two-dimensional shapes, three-dimensional shapes, and mathematical logic. Apart from preserving culturally significant traditional games and learning mathematics through play, these traditional indigenous knowledge systems can also foster a sense of patriotism, justice, tolerance, cooperation, and mutual assistance, demonstrating unity and harmony within the nation [50]. Ethnomathematics can address students' learning difficulties by linking local culture to mathematics learning topics [51]. Culture or inherited customs have educational value and are one of the educational values in mathematics education. Ethnomathematics serves as a bridge between mathematics and daily practices [52].

They are counting Principles oriented toward Problem Solving. Based on the principles of early counting ability, mathematical concepts need to be gradually introduced to children according to their level of mastery, including numbers, cause-and-effect patterns, geometry, and problem-solving. Problem-solving is an

important aspect of mathematics, and children need to be taught problem-solving strategies such as identifying problems, planning steps, trying solutions, and evaluating results. This principle helps them develop critical thinking, creativity, and problem-solving skills [53]. Children can acquire mathematical abilities, including problem-solving, in daily life, which helps them in decision-making, practical problem-solving, and critical thinking [54]. Counting principles oriented towards problem-solving can be achieved through role-playing, for example, playing a store where children can develop problem-solving skills by planning the necessary actions to sell their products effectively when they play the role of a seller [55].

Another similar perspective regarding problem-oriented counting principles suggests using busy books, placing children as active mathematical problem solvers, where they are given mathematical tasks or challenges that need to be solved through object manipulation, connecting mathematical concepts, or using appropriate counting strategies [56]. They were counting principles of repetition. Children's knowledge develops, is identified, and reinforced as they transition from one educational level to another. Repetition of what has been counted is crucial in learning counting to ensure accurate counting [57]. Children learn quickly but also forget quickly. Therefore, repetition in counting is done several times, and playing games on the same topic can help children remember [58]. Indirectly, children's focus can be trained through counting repetition, and their cognitive skills can be sharpened [59].

The novelty of this research lies in the discovery of six principles that serve as guidelines for teachers in teaching early counting to young children based on 52 literature review journals from four continents from 2020 to 2023. These nine principles include (1) One to One Correspondence Counting Principle, (2) Sequential Stable Counting Principle, (3) Cardinality Principle, (4) Irrelevant Order Counting Principle, (5) Abstract Counting Principle, (6) Memorization and Rational Counting Principle, (7) Counting principle using concepts from children's daily life, (8) Problem-oriented Counting Principle, (9) Counting Repetition Principle.

4 Conclusion

The nine principles of early counting for young children are important guidelines for teachers in teaching counting to young children. These nine principles include (1) One to One Correspondence Counting Principle, (2) Sequential Stable Counting Principle, (3) Cardinality Principle, (4) Irrelevant Order Counting Principle, (5) Abstract Counting Principle, (6) Memorization and Rational Counting Principle, (7) Counting principle using concepts from children's daily life,

(8) Problem-oriented Counting Principle, (9) Counting Repetition Principle. These principles are based on 52 literature review studies conducted in the past four years. This research is expected to advance knowledge about early childhood mathematics by teaching young children to count in a fun, accurate, effective, and efficient manner. Additionally, this research's findings can positively impact the role of prospective teachers, teachers, parents, and stakeholders in supporting the government's movement for numeracy literacy among young children in Indonesia.

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