

Innovative Pedagogy: Improving Early Childhood Numeracy Skills Using Manipulative Media

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ABSTRACT

This study aims to improve early childhood numeracy skills through the use of manipulative media in Class A of Al Ikhlas Kindergarten in Pekanbaru during the second semester of the 2023/2024 academic year. The research subjects consisted of 12 children (8 boys and 4 girls). The study used Classroom Action Research (CAR) in three cycles, with data collection methods including direct observation, photo documentation, and field notes. The research tools used for observation included a checklist to track children's ability to recognize and sequence numbers, match numbers with objects, and write numbers. The findings show significant improvement in numeracy skills across all cycles. At the pre-cycle stage, only 16.7% of the children demonstrated basic numeracy skills. After Cycle I, 50.6% of children were able to recite numbers 1-10 correctly. In Cycle II, 75% of the children could sequence numbers up to 20 and match numbers with objects. By Cycle III, 91.6% of the children showed strong numeracy skills, including writing numbers and distinguishing similar shapes, such as 6 and 9. The findings suggest that manipulative media, such as number blocks and number cards, are highly effective in improving early childhood numeracy skills. These results highlight the importance of using hands-on, interactive learning tools in early childhood education to foster cognitive development and engagement in learning. The study provides valuable insights into how educators can enhance numeracy education by incorporating manipulative media into their teaching practices, making learning more engaging and accessible for young children.

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1. INTRODUCTION

Cognitive abilities are necessary for children to develop their knowledge of what they see, hear, taste, touch, or smell through their five senses. Educators need to organise child-centred learning activities to develop their thinking skills, which requires providing them with various

play activities to explore their environment. According to (Noor, 2018), numeracy is one of the skills expected to develop in early childhood in accordance with their stage of development. Children's counting skills are the basis for the development of mathematical abilities that must be developed, including counting or reciting number sequences, counting to recognise number concepts with objects, imitating number symbols, and matching numbers with number symbols. The benefits of counting lessons for early childhood are learning basic mathematical concepts that are correct, interesting and fun, avoiding fear of counting lessons from the outset, and helping children learn to count naturally.

Counting skills are counting activities for early childhood, also known as number sequencing or blind counting. Children recite number sequences without referring to concrete objects. Children aged 4-5 years can recite the sequence of numbers up to ten, while children aged 5-6 years can recite numbers up to 1-20 or more (Malapata, 2019). Counting is an activity carried out in order to determine the number or quantity of an object. Counting is also an activity of connecting objects (one-to-one correspondence) with number concepts starting from the number one. The problem that has been occurring is that many children still have difficulty in counting, which causes their motivation to learn mathematics to decline. This is because teachers are not creative enough in providing learning media that is monotonous and makes children quickly feel bored. Teaching children to count when they are not ready or outside of their preparation will not have a good impact. Children will rebel, refuse, and easily get bored of learning to count or even experience pressure.

Helping children learn to count naturally is a fundamental aspect of early childhood education. Counting skills, broadly defined as the ability to recite number sequences and engage in blind counting (i.e., reciting numbers without immediately referencing concrete objects), are essential early math competencies. Young children aged 4-5 years typically begin by reciting number sequences up to ten, while those aged 5-6 years often extend this to 1-20 or more (Malapata & Wijayaningsih, 2019). Additionally, counting involves connecting objects with number concepts, following the one-to-one correspondence principle, which enables children to link each object with a distinct number starting from one (Stanford DREME TE, 2022).

Counting is not merely a rote activity—it's the process through which children begin to understand quantity, numbers, and ultimately the foundational mathematics that follow. In this process, children learn to determine the number or quantity of objects, match objects to number symbols, and internalize that each number represents a particular amount. For instance, when a child counts the blocks in a tray, they are engaging in one-to-one correspondence and linking the concrete to the abstract. Research on manipulatives has shown that concrete objects help make this bridge between tangible experience and formal number concepts (Sarama & Clements, 2016).

However, many children still face difficulty in acquiring counting skills, and this lack of proficiency often leads to a decline in motivation to learn mathematics. One persistent issue is associated with teaching approaches that are monotonous, overly abstract, or lack meaningful context—methods that fail to engage young learners. When teachers rely heavily on traditional, lecture-based instruction without interactive or tactile supports, children may quickly become bored or disengaged. A meta-analysis of math instruction using manipulatives found that although manipulatives can be effective, their success depends heavily on well-designed instructional contexts (Carbonneau et al., 2013).

Another risk arises when counting instruction is introduced prematurely, before children are developmentally ready or without appropriate preparation. In such cases, children may respond with resistance, refusal to participate, or behavioral disengagement—essentially perceiving the task as too difficult or disconnected from their world. For example, children may “rebel” or withdraw if asked to count in a setting that feels high-pressure or lacks meaningful

interactive structure. Researchers caution that manipulatives and counting activities must be developmentally appropriate and well scaffolded to avoid negative experiences (Moyer, 2001).

To address these challenges, educators are encouraged to adopt more dynamic and engaging methods of teaching counting. This means shifting from purely symbolic recitation to activities rich in hands-on manipulatives (blocks, number cards, concrete objects), purposeful play, and real-life contexts. Materials and activities should allow children to physically explore quantities, count objects they can see and touch, write numbers, and differentiate number shapes in a playful manner. Studies show that when children engage with manipulatives in concrete, meaningful ways, they not only develop stronger number sense but also develop more positive attitudes toward mathematics (Boz, Uludağ & Erdoğan, 2020). By making counting intuitive, child-centred, and enjoyable, teachers can create the conditions for children to build confidence and foundational math skills that support further learning.

According to (Anggraeni, 2016), manipulative media are concrete models that children can touch, see, and move, which serve to help children understand various mathematical concepts. Manipulative media are used by teachers as learning aids to explain learning materials. Lorton explains that manipulative media are any objects that can be seen, touched, heard, or manipulated. James states that manipulative media are concrete models that can be touched and moved by children, which serve to help children understand mathematical concepts.

Cognitive skills are essential for children as they develop their understanding of what they see, hear, feel, touch, and smell through their sensory experiences. Educators need to design child-centred activities that foster the development of thinking skills. Through engaging play and exploration, children can enhance their cognitive abilities. Counting ability is an essential developmental milestone for early childhood, forming the foundation of mathematical skills. The development of counting skills includes activities such as identifying number symbols, understanding one-to-one correspondence, and matching numbers with objects. Studies have shown that counting skills are crucial for early mathematics learning and should be taught in a fun and engaging way to avoid early fear of mathematics. However, many children face difficulties in learning to count, which leads to a decrease in motivation to learn mathematics. One key issue is the lack of creative teaching methods and engaging learning media, which can make learning monotonous and boring. This study aims to address this issue by exploring the use of manipulative media to improve counting skills in young children.

Based on field observations from July to October of the 2023-2024 academic year in Class A of Al Ikhlas Kindergarten in Pekanbaru, the researcher found that 10 out of a total of 12 children experienced problems with numeracy skills in the learning process. In this study, the researcher observed the following deficiencies in the children's numeracy skills: the children were still unable to recognise and sequence the numbers 1-20 correctly, they were still unable to match numbers with number symbols correctly, most of the children could only say the numbers but could not write them when instructed to do so, and the children often confused numbers (6 and 9). The researcher argues that, given these issues, improvements are needed in the learning process by adding an engaging learning medium to assist children in learning, thereby enhancing their numeracy skills at an early age.

2. METHODS

According to Bruns in the journal (Prihantoro & Hidayat, 2019), the important objective of classroom action research (CAR) is to identify a 'problematic' situation or issue that the participants who may include teachers, students, managers, administrators, or even parents consider worth looking into more deeply and systematically. Again, the term problematic does not mean that the teacher is an incompetent teacher. The point is that, as teachers, we often see gaps between what is actually happening in our teaching situation and what we would

ideally like to see happening. PTK does not stop at identifying problems, but also plays a role in overcoming these problems by making changes and improvements. These changes and improvements are based on information or in research terms data collected systematically. (Data is the plural form of datum in Latin, which means "something known"). In other words, the changes and improvements made in education are based on valid information, not just preconceptions, assumptions or feelings. This study used a Classroom Action Research (CAR) approach conducted in three cycles. Each cycle consisted of four main stages: planning, action, observation, and reflection. The research was carried out in Class A at Al-Ikhlâs Kindergarten in Pekanbaru during the second semester of the 2023/2024 academic year. The research subjects included 12 children, consisting of 8 boys and 4 girls.

The sampling technique used in this study was purposive sampling, where subjects were selected based on specific characteristics related to the study's objectives. In this case, the sample was selected based on the children's age and class at Al-Ikhlâs Kindergarten. The inclusion criteria were children aged 4-5 years enrolled in Class A, while the exclusion criteria were children with known developmental delays or learning difficulties. The children involved in the study were purposefully selected to ensure they represented the target population of children with difficulties in basic numeracy skills.

Data were collected through three main methods: Observations, test and documentation. The collected data were analyzed using both quantitative and qualitative approaches:

- a. Quantitative Analysis: Children's improvement in numeracy skills was measured by the percentage of children who achieved specific milestones in each cycle. For example, how many children were able to correctly recite the numbers 1-10 in Cycle I, or how many could write numbers independently in Cycle III. These improvements were tracked and compared across cycles to show the progression of numeracy skills.
- b. Qualitative Analysis: Field notes and photo documentation were analyzed to provide insights into the children's engagement with the learning activities and how manipulative media affected their attitudes and motivation. This qualitative analysis helped to understand whether the children felt more comfortable and interested in learning numeracy with manipulative media compared to other methods.

Additionally, descriptive statistical analysis was used to summarize the data, and comparisons between cycles were made to assess changes over time. If the data permits, statistical tests such as paired t-tests or ANOVA may be employed to determine whether the differences between cycles are statistically significant.

3. RESULTS AND DISCUSSION

This research was conducted in class A of Al Ikhlas Kindergarten in Pekanbaru, located at Komplek Abdi Jl. Jasa, Sukajadi, Pekanbaru City, in the second semester of 2023/2024. It involved 12 children, consisting of 8 boys and 4 girls, and aimed to improve the numeracy skills of early childhood through the use of manipulative media in the learning process () in Class A of Al Ikhlas Kindergarten in Pekanbaru. After the implementation of manipulative media in numeracy learning activities over several cycles, there was a significant improvement in the children's numeracy skills, see the table 1.

Table 1. Summary of Research Results

Cycle	Children Achieving Basic Counting Skills (%)	Children Able to List Numbers (1-10)	Children Able to List Numbers (1-20)	Children Able to Match Numbers with Objects (%)	Children Able to Write Numbers (%)	Children Able to Differentiate Similar Numbers (%)
Pre-cycle	16.70	2	0	16.70	0	0
Cycle I	50.60	5	0	50.60	50.60	50.60%
Cycle II	75	9	9	75	75	75
Cycle III	91.60%	11	11	91.60%	91.60%	91.60%

The problem identified in the initial stage (pre-cycle) was the children's low numeracy skills. Based on initial observations, it was found that out of 12 children, 10 children (or about 83%) were still in the "Not Yet Developed" (BB) category, with only 20% of their numeracy skills visible. This indicates the need for learning strategies that are more interesting and in line with the learning characteristics of early childhood, which are basically still concrete and require a play-based learning approach. Manipulative media was chosen as the main intervention in this study because it has the advantage of stimulating children's cognitive development, especially in mastering basic mathematical concepts. The media used included number blocks, number cards, and various concrete objects that children could manipulate directly to understand number concepts.

In Cycle I, learning began to apply the use of manipulative media in a guided manner. The results showed positive development, although it was still limited. Of the 12 children, 5 children (50.6%) were able to correctly recite the numbers 1–10 in order. The children showed increased interest in counting activities, but still had difficulty matching the number of objects with the corresponding numbers, as well as distinguishing between symbols that were similar in shape, such as the numbers 6 and 9. This became an important evaluation point in planning the next lesson.

In Cycle II, adjustments were made to the learning strategy, including intensifying the use of the " " and varying the use of manipulative media in a more structured manner. The children were given more opportunities to explore with concrete objects and participate in playful counting activities. The impact was quite significant. A total of 9 children (75%) showed improved abilities, such as correctly sequencing numbers 1–20, matching the number of objects with the corresponding number symbols, and beginning to write simple numbers. The children also began to be able to distinguish between visually similar numbers, indicating an improvement in their reasoning and visual perception of number shapes.

The most significant progress was seen in Cycle III, where 11 out of 12 children (91.6%) demonstrated a good understanding of counting activities. The children were able to recite the sequence of numbers 1–20 without assistance, connect the number of concrete objects with the appropriate number symbols (one-to-one correspondence), write numbers, albeit in their early form, and distinguish between similar numbers such as 6 and 9 more accurately through fun number games.

This shows that manipulative media is very effective in building a strong foundation in counting for early childhood. In cycle III, the results obtained increased further, with 11 out of 12 children (91.6%) demonstrating good understanding in counting activities. Children were able to recite the numbers 1–20 without assistance, connect the number of concrete objects with the correct number symbols (one-to-one correspondence), write numbers

independently, albeit still in their initial form, and distinguish between similar numbers such as 6 and 9 more accurately through number games. Learning activities that use manipulative media have also been proven to increase children's motivation and enthusiasm in participating in the learning process. Children appear to be more active, directly involved, and show joy and are not stressed when learning to count.

In addition to improving children's cognitive counting abilities, the use of manipulative media also exerts a significant positive influence on their affective and motivational domains. When early childhood learners engage with concrete materials such as number blocks, cards, and tactile objects they not only process numerical concepts but also experience learning as more inviting and less intimidating, (Ratnasari, 2020). Research indicates that manipulatives enhance children's engagement, fostering heightened interest and active involvement in mathematical tasks. During the learning process, children who work with manipulative media appear more motivated, enthusiastic, and dynamic in their interactions. They often show greater willingness to participate, ask questions, explore, and experiment with the learning materials. According to Laski (2015), students who used manipulatives reported higher levels of enjoyment and interest in mathematics compared to those in conventional settings. In effect, the hands-on nature of the media helps reduce learning anxiety and supports a mindset of exploration and curiosity.

One of the key advantages is that young learners become directly involved in the learning process rather than being passive recipients of instruction. They manipulate objects, test ideas, correct mistakes, and visually see the consequences of their actions thereby internalizing numerical concepts through play, (Landry et al., 2014; Tobin, 2005). A systematic review found that manipulative interventions for pre-primary and primary age children improved not only cognitive outcomes but also engagement and motivation in learning tasks. By designing activities that feel like play rather than formal drills, children show less resistance and more willingness to persist with challenging content. They also tend not to feel pressured or anxious when using manipulative media: instead of a high-stakes, error-avoiding atmosphere, the classroom becomes one where children feel safe to experiment and express their thinking (Cohen, 2001; Tout & Schmitt, 2002). This shift in emotional climate supports better learning outcomes because motivation, affect, and cognition are interconnected. For example, in studies on early mathematics, the teachers observed children expressing enjoyment and confidence when they could physically handle and see the numerical representations during lessons. The physical manipulation of materials thus contributes to both skill acquisition and positive emotional engagement.

Finally, playful and interactive activities provide a fun and meaningful learning experience for children that extends beyond mere counting. When manipulative media are used, children develop not only number sense but also fine motor coordination, spatial awareness, social interaction (when they work in pairs or groups), and communication skills as they explain their actions. This holistic benefit has been noted in research showing that manipulative-based activities help young children build confidence and a positive attitude towards mathematics. In short, integrating manipulative media does not just support cognitive development it enriches the full learning experience in early childhood settings.

In addition to improving cognitive counting skills, the use of manipulative media also has a positive impact on children's affective aspects. During the learning process, children appear more motivated, enthusiastic, and active. They are directly involved in the learning process, do not feel pressured, and instead show expressions of happiness when learning to count. Playful and interactive activities provide a fun and meaningful learning experience for children. Overall, the results of this study indicate that the use of manipulative media in learning arithmetic not only improves children's cognitive abilities in understanding number concepts but also supports the development of fine motor skills, visual perception, and social

and communication skills. Children become more confident, enjoy learning, and are actively involved in the learning process.

4. CONCLUSION

Based on the results of the study conducted in Class A of Al Ikhlas Kindergarten in Pekanbaru during the second semester of the 2023/2024 academic year, it can be concluded that the use of manipulative media has proven to be an effective approach in improving the numeracy skills of early childhood children. Through the implementation of three learning cycles, there was a significant increase in children's numeracy skills, particularly in the areas of number sequence recognition, matching numbers with objects, distinguishing between similar numbers, and writing numbers independently. At the pre-cycle stage, most children were still categorized as "Not Yet Developed," with limited understanding of number concepts. However, after the introduction of manipulative media such as number blocks, number cards, and other concrete objects, children's numeracy skills improved from 50.6% in Cycle I to 75% in Cycle II, and reached 91.6% in Cycle III.

In addition to cognitive improvements, the use of manipulative media also successfully increased children's motivation, enthusiasm, and active involvement in the learning process. Children appeared more engaged, happier, and less stressed during the learning sessions, which indicates that the use of manipulative media aligns well with the developmental characteristics of early childhood learners. Given the effectiveness of manipulative media in enhancing numeracy skills, it is highly recommended for educators to incorporate these tools into early childhood mathematics instruction. Teachers can use number blocks, number cards, and other tangible materials to create a hands-on, interactive learning environment that encourages active participation and deeper understanding. Educators should consider integrating these materials into daily lessons and offer ample opportunities for children to explore and manipulate these objects to solidify their grasp of basic mathematical concepts.

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