

MATHEMATICAL LANGUAGE'S FEATURES OF PRESCHOOL CHILDREN

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Abstract. Mathematical language is an important aspect of the comprehensive development of young children. Creating a learning environment and real-life experiences for children contributes to the development of their ability to use mathematical language to solve practical situations. This article focuses on studying the characteristics and factors affecting mathematical language in early childhood to determine children's ability to use mathematical language and provide a foundation for teachers to choose suitable methods and organize educational activities for preschool children.

Keywords: early childhood education, preschool children, mathematical language.

1. Introduction

Mathematics plays a crucial role in the intellectual development of children, helping them develop skills in exploration, observation, and logical thinking in their daily activities. As society is becoming increasingly modernized, individuals need to possess actively in learning skills, be flexible and creative in working skills, as well as think logically and maximize judgment and reasoning abilities to meet the demands of practical situations.

For preschool children, mathematics not only provides them with basic math knowledge but also “shapes their thinking and working methods of mathematical science” [1]. In the preschool education program, mathematics provides fundamental knowledge for young children and lays the foundation for the learning process in secondary education. Children's initial mathematical concepts are primarily formed through visual aids, based on their own experiences and initial life experiences. Through this, they develop skills in applying mathematical knowledge in practical situations, which arouses their interest and enthusiasm during the learning process.

Preschool children need equipping with knowledge and skills as a preparation for entering secondary education. Mathematical language education makes a significant contribution to this important transitional stage. Mathematical language provided in preschool education is a foundation that helps children understand nature and accurately apply different forms of mathematical language (mathematical symbols, expressions, etc.) in the next stages of education.

By qualitative research method, the research focuses on clarifying the characteristics of mathematical language in preschool children, providing a basis for educators to choose methods and organize purposeful learning activities that promote children's ability to use mathematical language effectively in preschool.

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2. Content

2.1. Mathematics and language

In all activities of children in preschool, language plays an important part of learning. Mathematical activities are not exception. According to Clements [2], we may look at mathematics in preschool as a language based on structure and logic, where children show off their knowledge with mathematical concepts is necessary not only for the initial formation of mathematical symbols for children but also for the development of children's thinking in the next stages.

Children's development of mathematical vocabulary has a close relationship with the effectiveness of children's math activities in the future. Their mathematical language is created through dialogues and interactions between adults and children. Bishop [3] divides children's experience with mathematics into six fundamental mathematical activities: explanation, locating, measuring, counting, design, and playing. He states that these mathematical activities are independent of culture and are reflected in children's daily lives. Bishop believes that the number of activities is not vital. What is crucial is how these six mathematical activities might help us gain a broader and more nuanced perception of what mathematics is for preschool children.

Children who are not good at mathematical language and concepts may feel challenged that they cannot understand the mathematics required in each task. In mathematics, a mathematical language is a verbal and written linguistic expression, body language, such as looks, gestures and movements, and characters, words, and number symbols [4]. However, understanding a concept is not only about recognizing the word that denotes that concept, but also requires children to have the skills to apply those concepts in real-life situations, in different contexts, and with different meanings, and to understand not only the concept in Mathematics but also the other meaning of the word. Understanding mathematical vocabulary allows children to understand the meaning of mathematical dialogues with others as well within instructional learning activities.

Furthermore, it is crucial for pre-school educators to actively incorporate mathematical language in a reflective manner to facilitate children's comprehension of fundamental mathematical concepts and encourage them to engage in mathematical thinking. By enhancing the play environment, pre-school teachers can enable children to experience the pleasure of mathematics. In this educational approach, play-based learning is central in kindergarten, as it is child-centered, and based on the pedagogical assumption that children are active learners in a socio-cultural setting. According to socio-cultural theory, communication and language play a significant role in connecting the child with their environment. This theory is rooted in Vygotsky's work [5], in which language is considered the foundation of all thinking. To comprehend this perspective, the notion of language needs to be broadened to include other forms of expression, such as drawings, body language, and gestures. Ehrlich, Levine, and Goldin-Meadow [6] suggested that using gestures to instruct children can have a considerable and favorable effect on the development of early spatial skills. Gesture offers children an additional, complementary problem-solving technique that can be integrated with verbal language, resulting in a better understanding of the principles of mathematical equivalence.

2.2. Mathematical language of preschool children

Researchers both within and outside of Vietnam have different views on mathematics in general and mathematics for preschool children in particular.

Mathematical concepts play an important role in accessing mathematical properties. According to L. Diane Miller [7], mathematics is a language consisting of symbols to accurately express basic concepts of mathematics. Describing mathematics in more detail, O'Halloran [8]

said that mathematics is a system of diverse symbols, including symbols, language and visual image. Mathematics is understood in a certain sense as a language to describe specific situations arising in scientific research or in practical human activities. However, the view of Italian astronomer and physicist, Galileo Galilei [9] believes: "Mathematics is the language in which God wrote the universe". According to Clements [2], we may look at mathematics as a language based on structure and logic, where rich interaction with mathematical concepts is important for the development of children's mathematical knowledge.

Based on the views of mathematics, scientists share their own perspectives on the language of mathematics. The language of mathematics is the language of symbols, concepts, definitions, and theories. To form mathematical language, children need to learn with the support of educators and people around them because mathematical language does not develop as naturally as natural language. Mathematical language includes symbols, terms (words, phrases), symbols, and rules for their combination that are used as means of expressing mathematical content in a logical, precise, and clear manner. Symbols include numbers, letters, alphabetic characters, signs of operations, relation signs, and brackets used in mathematics. An icon consists of an image, drawing, diagram, or model of a particular object.

However, the mathematical language of preschool children possesses age-specific characteristics. According to Fuson [10], the mathematical language of preschool children is the ability to use terms, symbols and calculations to describe objects, events and relationships in the mathematical world. Research by M. Nunes et al [11] defines the mathematical language of preschool children as "the ability to use mathematical concepts to describe, describe, explain and solve mathematical problems in real life. daily". The mathematical language of preschool children includes concepts such as numbers, shapes, sizes, positions, time, and units of measurement. The mathematical language of preschool children also includes the ability to count, classify the surrounding phenomena, expand, and develop through practical activities. Ginsburg [12], who has contributed a lot of research related to the mathematical language of children in the first years of life, said that the mathematical language of preschool children is understood as the ability to use mathematical concepts, terms, and symbols to describe them, compare and solve simple math problems. Thus, the mathematical language of preschool children can be formed and developed simultaneously, inseparable from the natural language development of children.

The mathematical language of preschool children is a set of mathematical vocabulary, symbols, and basic concepts that children use to convey meaning and solve practical situations related to mathematics.

2.3. Methodology

Design, data, and participants

The data used in this study is a part of the data set collected for my PhD thesis. The observations of everyday activities in Hoa Sen kindergarten were collected over a period of three weeks in a privately-operated kindergarten, in Hanoi. This kindergarten is the practical school of the National College for Education, which is researching and applying current advanced preschool education methods. The participants are preschool teachers and 30 children from 5 to 6 years old in this kindergarten.

Observation methods were used in both direct and indirect forms. The researcher noted the necessary information for analysis. During the observation process, we used a combination of conversational methods with children by asking questions to create conditions for children to express the research contents that are of interest. The teachers used a particular method when they were working on experimentation. The teachers illustrated and explained a natural

phenomenon, then asked children some questions like: “What does this look like?”, “Why do you think this happens?” and “Why would this one sink/float?”. The children participated by answering, describing, asking questions, and experimenting in different ways based on their thought.

In addition, the teachers participated in a short interview related to children's mathematical language as factors affecting preschool children's mathematical language development in and outside preschool.

Analytical approach

The analytical method is used to make continuous comparisons in which comparisons are placed in the specific context of when and how adults and children use language mathematics. Their activities are recorded by hidden cameras. The recorded videos have been synthesized and encoded by professional operations. Live video encoding allows both verbal and visual cues to be considered, such as gestures, movements, and manipulation of learning materials. The interview results were also coded and processed through AMOS software - a qualitative research data processing software. Research results were summarized and analyzed according to the following issues.

2.4. Factors affecting the mathematical language of preschool children

In this research, we will not discuss the influence of innate or genetic factors on the mathematical language of preschool children. Instead, the research emphasizes the dominant role of adults in the process of interacting and organizing activities to create an environment for children to develop their mathematical language.

The influence of policy in education: Policy plays an important role in guiding and promoting the development of education in general and mathematical language education for preschool children in particular. A study by Christina Weiland and Hirokazu Yoshikawa [13] examined the impact of the government-funded preschool education system on children's awareness of reading, language development, and mathematical symbol skills. The study surveyed 2018 preschoolers aged 4-5 years old. The results showed consistency between the curriculum framework and the knowledge and skills of the children, with a focus on the program's stated goals. The study showed that the program had a significant impact on the language, reading, math, and mathematical skills of children, and had a minor impact on their general ability and emotional scale. The study confirmed that the above preschool education program can improve the effectiveness of education for children in necessary and meaningful ways. Therefore, policy can support the training and development of human resources for education, and provide standards and guidance for mathematical language education for preschool children to ensure the consistent rights of all participants in the national education program.

The influence from family: Family is considered the "first school" of every child. The mathematical language of children is formed and influenced during the communication process with their mothers in the family environment. Maria Ines Susperreguy and Pamela E. Davis-Kean [14] analyzed the relationship between the mathematical knowledge children gain through communication with their mothers at home and their ability to absorb it at preschool after one year. 40 mother-child pairs recorded their spontaneous conversations at home using high-quality audio recording devices. The results from the random sample group showed that all participating mothers created opportunities to exchange various mathematical topics with their children at home, especially during meal times, despite differences in the amount of mathematical knowledge the children received. Furthermore, exposure to many mathematical dialogues positively influenced the children's mathematical learning activities in preschool one year after the survey. The research group also collaborated with mothers to provide

guidance on adjusting the way they talk with their children and recorded the adjustments after each conversation. Through this method, the study showed that the collaboration between mothers and children not only helps children access mathematical knowledge in a natural context but also provides parents with the knowledge to develop mathematical vocabulary for their children through daily conversations at home. In addition, the study provided information for preschool teachers about the mathematical knowledge children received at home, which is the basis for teachers to expand and improve children's awareness based on the existing knowledge.

The influence from the school environment: Schools have a significant impact on the formation and development of children's mathematical language, including teachers, teaching methods, learning resources, and the learning environment. Teachers play a crucial role in guiding and supporting children's activities in preschool. Their level of expertise, teaching methods, and forms of interaction directly affect children's learning activities. If teachers have high levels of expertise, good teaching skills, and educational abilities, they can help children develop their mathematical abilities. Conversely, if teachers do not have enough knowledge and expertise, it will be challenging for children to learn and develop their mathematical language. Learning resources are also considered an essential factor in developing children's mathematical language in preschool. Rich and diverse learning resources are advantageous conditions for effective communication between teachers and children and for children to absorb knowledge effectively and conveniently. Additionally, a friendly, safe, comfortable, and confident learning environment is necessary for children to participate in activities. The school environment needs to be well-designed and organized, ensuring all the above factors create favorable conditions for children to develop their mathematical language.

2.5. Characteristics of the mathematical language of preschool children

Mathematical language is one of the initial indicators of mathematical ability in preschool and early elementary school. Mathematical language is used to describe the structure and essence of mathematical concepts. Language plays an important role in expressing children's understanding of mathematical concepts. In the process of forming mathematical symbols for children in preschool, Mathematical language is a combination of spoken language, body language (posture, gesture, action), and symbolic language (characters, numerical symbols). However, understanding the essence of a concept is not simply recognizing the language that represents it. Children need to have the skill to use appropriate vocabulary for each context with different meanings. Understanding the meaning of mathematical vocabulary contributes to expanding opportunities for children to explore mathematics; creating enthusiasm and readiness to participate in other purposeful learning activities.

Beate Nergård has observed and studied how preschoolers use the language of mathematics. Based on the data analyzed from the study, mathematical language for preschool children is classified into two types: quantitative language and spatial language. Quantitative language includes a system of vocabulary, symbols, and signs that refer to quantity. Understanding quantitative language helps children easily perform and describe comparisons between numbers and quantities around concepts such as few, fewer, fewest, many, more, most, etc. Counting numbers and their order are concepts that children often struggle with when approaching math, as teachers often explain to children based on their own understanding using spoken language.

Spatial language includes a group of vocabulary that refers to the position in space (such as above, in front of, near, behind, before, etc.). Some spatial vocabulary also indicates the magnitude of the counting number in each sequence or indicates an increase or decrease in quantity. The ability to understand spatial language is closely related to children's spatial

thinking, contributing to the development of necessary spatial orientation skills in math and other activities. In addition, children with rich spatial language have better imagination. They can easily express their own ideas, especially in designing and arranging space or building any model. Children can do this individually or in groups. When participating in group activities, to achieve effectiveness and accurately express ideas, children need to use vocabulary related to space to communicate with other children.

Most preschool children have difficulty of understanding different aspects and levels of mathematical quantities (such as comparisons, and superlatives). This can become a limitation in expanding and developing mathematical knowledge in the future. In a recent study, Purpura, Day, Napoli, and Hart [10] found that among many learning skills and accumulated knowledge in preschool education (such as mathematical language, computational skills, estimation skills, synthesis skills, general vocabulary, alphabet recognition, etc.), mathematical language is the most effective and consistent classification tool for children who have difficulty learning in preschool (surveyed results for 5-6 year-olds). These findings show that difficulty in using mathematical language can hinder children from acquiring mathematical skills when attending preschool. The reason for this is that children who have a late introduction to mathematical language (specifically, starting school later than those who attend preschool early) often have a lower mathematical language foundation. At the same time, most of them face difficulty when participating in activities that involve forming mathematical symbols with guidance from teachers because they do not understand the language used in the process of discussing, explaining, or discussing related mathematical concepts. Meanwhile, children who attend school earlier or at the right age may have low mathematical skills but have less difficulty using mathematical language. Mathematical language used in communication and guidance from teachers has a positive impact on children. It can be said that children benefit from listening to instructions and chatting with teachers.

The mathematical language of preschool children is manifested in three aspects: expressive language (spoken language), receptive language (listening and understanding language), and social interaction (children using language in real communication situations). At this stage, the mathematical language of children has some notable common characteristics as:

Firstly, children often use simple and concise language, closely related to visual images.

Preschool children's mathematical language is often characterized by its simplicity and reliance on visual images. This is because young children are still developing their cognitive and language abilities, and they often rely on concrete experiences and visual aids to help them make sense of mathematical concepts. Due to their limited vocabulary, children mainly use simple and easy-to-understand words to describe and express situations involving mathematical elements, such as many, few, big, small, long, short, etc. Children use simple language to describe what they observe. The language that children use often reflects the moment and has a direct connection with the objects and phenomena that children are perceiving. Through the language that children use, educators can grasp and evaluate the level of children's cognition to have appropriate educational impacts.

In addition to using simple and concise language, preschool children's mathematical language often involves counting and basic arithmetic. For example, they may use counting to describe the number of objects in a set, or use simple addition and subtraction to solve basic problems. Their language may also include basic geometric concepts, such as shapes and spatial relationships.

Preschool children's mathematical language is closely tied to their overall mathematical development. As they become more comfortable with mathematical concepts, they may begin to use more abstract language and symbols to describe their thinking. They may also begin to use

mathematical language to explain more complex mathematical concepts, such as patterns, measurement, and geometry.

Secondly, children often use visual aids to assist their expression.

Preschool children's mathematical language is often characterized by its reliance on visual aids to assist their expression. This is because young children are still developing their cognitive and language abilities, and they often rely on concrete experiences and visual aids to help them make sense of mathematical concepts.

Visual aids can take many forms, including manipulates such as counting blocks or geometric shapes, pictures or diagrams, and even gestures or movements. For example, a preschooler might use a diagram or picture to describe the concept of addition, showing a group of objects with two more added to it to represent the sum. They might also use gestures or movements to help them understand spatial relationships or geometric concepts.

Visual aids not only help preschool children understand mathematical concepts, but they also assist them in communicating with others. By using visual aids, preschool children can make their mathematical thinking more concrete and accessible to others, even if their language skills are still in developing. Children often choose images or objects to illustrate and explain real-life mathematical situations, through which mathematical symbols are formed. The mathematical language that children use describes the size, quantity, and position of any object in space. For example, when comparing the size of an object, children will seek an object of similar size and may use spoken language to describe the compared image, such as "This bean is as small as my mom's hair clip." To help children understand the concept of "adding/subtracting," teachers can choose to use any object and illustrate the addition/subtraction operation. In this way, mathematical concepts are presented to children in a simple, visual, and understandable way.

Thirdly, the ability to use mathematical language appropriately in communicative contexts is limited.

Although visual thinking and the formation of mathematical language are closely related, the ability to use mathematical language appropriately in communication contexts is still limited at this stage. This is because young children are still in the process of developing their language abilities, and they may struggle to communicate their mathematical thinking effectively. Children's vocabulary is not yet fully developed, and their skills in expressing and explaining specific issues are still challenging. Children can recognize and classify objects according to simple criteria. A preschooler might have a good understanding of the concept of addition but may have difficulty explaining their thinking to others using appropriate mathematical language. They may use imprecise language or struggle to use the correct mathematical terminology, which can make it difficult for others to understand their thinking.

Preschool children's limited ability to use mathematical language appropriately in communicative contexts is also related to their limited experience with mathematical concepts. They may not yet have a strong understanding of the different mathematical operations, or opportunities to apply their mathematical thinking in real-world situations. Children tend to use inappropriate or insufficient language to express their ideas about the issues they want to convey.

To support preschool children's development of mathematical language skills, educators need to use appropriate teaching methods and forms to help children acquire a rich vocabulary, meet communication needs, and handle situations using appropriate mathematical language in each context. The use of visual aids can help children understand the nature of primitive mathematical symbols more clearly, and at the same time, help children use mathematical language more effectively and accurately. In addition, children need to participate in

experiential activities that apply their mathematical knowledge to solve practical situations, develop reasoning skills, and apply mathematical language to specific situations.

Fourthly, children do not have the ability to use mathematical expressions and symbols yet.

Preschool children's mathematical language development is characterized by a limited ability to use mathematical expressions and symbols. This is because young children are still in the process of developing their cognitive and language abilities, and they may not yet have the ability to understand or use abstract mathematical concepts and symbols.

For example, a preschooler might understand the concept of addition and be able to count objects to find the sum, but they may not yet have the ability to understand or use the plus sign (+) or the equals sign (=) to represent addition. Similarly, they may understand the concept of shapes and be able to identify them, but they may not yet have the ability to use geometric symbols to represent them.

As preschool children progress in their mathematical learning, they will begin to develop the ability to use mathematical expressions and symbols to represent mathematical concepts. However, this development takes time and practice, and it is important to provide opportunities for children to work with concrete materials and visual aids before introducing abstract concepts and symbols.

Fifthly, the mathematical language of children begins counting and using counting to count any objects.

Preschool children's mathematical language development typically begins counting and using counting to count any objects. Counting is one of the most fundamental mathematical concepts, and it is a critical foundation for all future mathematical learning.

At first, children observe, listen, and imitate the sounds made by adults. For example, at home, children are often taught to count in order from 01 to 10. However, children only hear and repeat the sounds they perceive. Children do not understand the essence of each counting number they are saying immediately. Along with the guidance and support of adults, children begin to apply their vocabulary to count objects around them, such as toys, candies, or fingers. The sound of children becomes meaningful. However, the use of counting and counting operations by children is not flexible. Children often count by listing numbers from 01 to the last number to count the number of any group of objects. The number may exceed the amount that children can count by eye, such as counting pens. Children will arrange pens horizontally and count by listing from number 01 to the last number they know to determine the number of pens. If there are 08 pens, but children know up to number 10, they will continue counting to 10 even though the actual number of pens is only 08. Then, when asked, children will answer that there are 10 pens.

When children first begin to develop their mathematical language skills, they often use counting to describe the number of objects in a set, to compare quantities, and to solve basic arithmetic problems. They may use informal language to describe their thinking, such as "I have three blocks" or "I need two more to make five."

As preschool children progress their mathematical learning, they will begin to develop a more sophisticated understanding of counting and number sense. They will learn to count in sequence, to count objects in different configurations, and to use counting to solve more complex problems.

In addition to counting, preschool children's mathematical language development also involves the development of other fundamental mathematical concepts. These may include basic geometric concepts, such as shapes and spatial relationships, as well as concepts related to measurement, patterns, and data analysis.

Sixthly, children have the ability to solve simple mathematical problems.

Preschool children's mathematical language development is characterized by their ability to solve simple mathematical problems. While their problem-solving skills are limited, young children are able to apply their understanding of basic mathematical concepts to solve problems they encounter in their daily lives. The ability to solve simple mathematical problems in the mathematical language of preschool children depends on the level of development of basic skills such as counting, comparing, classifying, and grouping. Children can find a set of objects in the same group, compare the number of objects between two groups, or classify a group of objects based on simple criteria (color, shape, function, etc.). For example, a preschooler might use counting to solve a problem such as "How many crackers do I need for my snack?" or "How many blocks do I need to build a tower as tall as my friend's?" They may also use basic arithmetic, such as addition and subtraction, to solve problems such as "If I have two apples and I give one to my friend, how many do I have left?"

While preschool children's ability to solve problems is limited, they are able to develop their problem-solving skills through playing and exploring. Children are in the process of exploring and developing initial understandings about the world around them, so they need to be guided and given opportunities to apply these skills in practical situations. By providing opportunities for children to work with concrete materials and visual aids, teachers and caregivers can support the development of problem-solving skills and help children build a foundation for future mathematical learning.

In addition to developing problem-solving skills, preschool children's mathematical language development also involves the development of other fundamental mathematical concepts. These may include basic geometric concepts, such as shapes and spatial relationships, as well as concepts related to measurement, patterns, and data analysis.

Preschool children's mathematical language development is characterized by their ability to use simple and concise language, often related to visual images. They rely on concrete experiences and visual aids to make sense of mathematical concepts, and their ability to use mathematical expressions and symbols is limited. However, preschool children have the ability to solve simple mathematical problems and begin to develop a more sophisticated understanding of mathematical concepts as they progress in their learning. Teachers and caregivers can support preschool children's mathematical language development by providing opportunities for hands-on exploration and play with mathematical concepts, modeling appropriate mathematical language use, and creating a supportive learning environment that encourages children to explore and experiment with mathematical ideas. By doing so, we can help children build a strong foundation for future mathematical learning and success.

3. Conclusion

Mathematical language for preschool children is closely related to their future learning of mathematics. Mathematical language reflects children's thinking and understanding of a specific mathematical problem applied in practical situations. Based on the expressions revealed in the process of using mathematical language by children, the level of understanding can be determined to have appropriate methods and forms of support to reinforce the initial basic mathematical symbols for children accurately. From there, children can accurately apply and develop their mathematical language knowledge in different forms of presentation with higher general significance in secondary education.

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