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& Ali İbrahim Can GÖZÜM

New Horizons in Early Childhood Education

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Table of Contents

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Foreword

Technology has influenced all the aspects of our lives by causing inevitable changes and improvements in every field. Naturally, the world of science has greatly benefited from this change and development. In consequence, the rapid circulation of information and technology in the scientific world has increased the cooperation among scientists. This cooperation highly contributes to researches and studies in the fields of language, history, literature, education, economy, social and cultural life, politics, sports, tourism, and media and communication along with many other areas.

Thus, this book contains different researches in **New Horizons in Early Childhood Education studies** in parallel with the improvements in the world of science. It took about one year to prepare and print the book. We would like to express our deepest gratitude to our friends who contributed to this process. We also thank SRA academic publishing staff.

Finally, very special thanks go to the authors who contributed to our book with their researches. It is our greatest wish that this book will increase the cooperation among scientists to make the world a better place.

Kind Regards.

Editors

Fatma ALİSİNANOĞLU, Vedat BAYRAKTAR & Ali İbrahim Can GÖZÜM

08. 10. 2019

CHAPTER 13

Math Education with Play Activities in Early Years

Perihan Tuğba ŞEKER[1], Hatice Şebnem ÇETKEN[2] & Emine KILINÇCI[3]

Introduction

Mathematics in Early Childhood

Mathematics education in early childhood is crucial for children to develop a positive attitude towards mathematics and to support their basic academic skills. Furthermore, it encourages children's variety of abilities such as questioning, wondering, investigating, reasoning, and problem-solving.

The experiences related to mathematics gained to children in the preschool period will change the children's perspectives towards mathematics in later life. If children have comprehensive experience in childhood, they will have a confident attitude when they faced with the knowledge of theoretical mathematics in the elementary school years because the preschool period is one of the most critical periods in which the foundations of mathematics are laid for children in the coming years (Oktay, 2000). In particular, the fact that children do not form a prejudice and fear against mathematics in elementary and high school years when they encounter mathematics teaching is directly related to mathematics education in preschool period (Tuğrul, 2002).

Many expressions used by children during the day include mathematical concepts such as quantity comparison, mathematical operation, measurement, and position (Umay, 2003). As it is known, children may not always use scientific language to express mathematical concepts. They come to pre-school education institutions to understand and express mathematical concepts. (Diaz, 2008).

By taking into consideration the developmental tasks of children in pre-school education, many subjects of mathematics are included, albeit superficially. Thanks to this, children can develop a basis of mathematical knowledge to provide easier and quicker learning of elementary mathematics (Umay, 2003). There are mathematical skills among the universal skills that preschool children should learn. These skills are as follows: Number concept, Model making and associating, Geometry, Measurement, Collecting information, Organizing, Expressing (Dodge, Colker, Heronon, 2002). In addition, the mathematical performance consists of several components such as basic

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number knowledge, memory for arithmetic facts, understanding of mathematical concepts and ability (Aunola, Leskinen, Lerkanen, and Nurmi, 2004).

Children's experience in mathematics from a very early stage provides development of skills related to mathematical concepts, matching, comparison, distinguishing similarities and differences, organizing information within categories, measuring, problem-solving, piece-whole, modeling and relationships, geometry, data collection, and analysis.

In order to teach mathematical concepts to preschool children and to incorporate mathematics into children's daily lives, children should first awaken their curiosity and give examples that children can use mathematics in everyday life. According to White (2002), the number concept develops as children engage in their daily activities by thinking, exploring, and discussing in this process. At this point, teachers and the educational environment created by teachers form the basis for the development of the concept of number for children (as cited in Jackman, 2012, p. 152).

Theoretical Mathematics in Early Childhood

Individuals internalize knowledge with environmental experiences (Kamii, 2004, p. 2). According to Piaget and Vygotsky, children learn mathematics by interacting with their environment in the pre-school period (Akman, 2002).

Piaget and Math Education

Piaget has scientifically proven how each child constructs mathematical knowledge. Children can build mathematical concepts without any teaching (Kamii,2004: 3).

In particular, Piaget underlined that the child constructs information by interacting with his environment. (Charlesworth and Radeloff, 2013, p. 3). Concepts are acquired when children actively interact with the environment, and as they discover the beings around them, they construct their knowledge.

According to Piaget, the child should be active in affective, cognitive, and physical learning processes. The teacher has a significant role in providing opportunities to children for investigating and questioning the mathematical operations in a rich, supportive, and stimulating environment (Aktaş Arnas, 2013).

In Piaget's view, children acquire and construct information when interacting with their environment (Charlesworth and Radeloff, 1991, p.7). The mechanisms that Piaget predicts for cognitive development and change 'assimilation and accommodation' explain scientific learning in early childhood (Alisinanoğlu, Özbey and Kahveci, 2007). Piaget mentions three kinds of information: physical knowledge, social, traditional knowledge, and logical-mathematical knowledge. Physical knowledge includes information about objects in the outside world (color, smell, etc.). Logical-mathematical knowledge includes mental relationships (Kamii, 2004, p.5). The child obtains the most appropriate opportunities to establish mental relationships while he is playing. Vygotsky argued that the child's mental development is not a process as Piaget suggests that the child practices on his own. According to Vygotsky, mental development is dependent on others. There are behaviors that he has accomplished on his own, as well as behaviors that he has not yet achieved on his own, but that he can make with the help of an adult (Bacanlı, 2006).

Vygotsky and Math Education

Vygotsky recommends that both developmental and environmental factors be considered in cognitive development. He emphasizes two concepts which are children can learn in their daily lives and can process in school by allowing them to discover on their own. At school, two kinds of concepts interact with each other. The scientific concept enables cognitive development to reach new goals in the teacher's control. Children will act based on spontaneous concepts while learning new concepts. In Vygotsky's perspective, children need to be given new concepts with arranging environment and opportunities to discover.

Early Childhood Mathematics Education Program Standards

In early childhood education, national program standards exist in different countries (Bradekamp, 2004). According to Charlesworth and Lind (2013), the standards guide what age level children should know and be able to do. If program standards are wanted to be applied, these standards should be linked to the program, the teaching process, and the evaluation process. It is essential to distinguish between what children can learn and what they should learn. Standards in mathematics education also provide information about the cognitive capacity of the child (Bradekamp, 2004).

National Council of Teachers of Mathematics (2000), defines ten necessary standards for mathematics education in children aged 3-5 years (prekindergarten) and 7-8 years (grade 2) (Charlesworth and Lind, 2013, p. 3). The first five standards are probability, mathematical operations, algebra, geometry, measurement, and data analysis. The following five standards include problem-solving, reasoning, connections, communication, and symbols. These two groups of standards are interconnected and mathematics education applications in abroad, process standards are applied to learn content standards (Charlesworth and Lind, 2013, p.3; Sheffield and Cruikshank, 2005, p.7). Akman (2002) states that these standards are divided into two as thought oriented and content.

In 1989, NCTM published standards for the evaluation and teaching of mathematics education programs for 17-18 years of age children in kindergarten. These standards are applied in various countries, especially in the USA and Canada. After that, the Professional Standards for Teaching Mathematics (NCTM, 1991) and Curriculum and Evaluation Standards for School Mathematics (NCTM, 1995) were published. In 2000, with the review of the previous publications, a publication called as Principles and Standards for NCTM School Mathematics was re-released, the most critical feature of which was the staging of the preschool period. In the first step, the period between 3-5 years and 7-8 years was discussed. In 2002, NAEYC (National Association for the Education of Young Children) established in the US, and US NCTM (National Council of Teachers of Mathematics) has published an assessment of the situation for early childhood mathematics education. Focusing on NCTM 2000, the focus is on 3-6 age mathematics.

Content standards within the scope of standards in mathematics education shed light on what children should learn, and process standards explain in which ways they should learn (NCTM, 2000). Not all standards are expected to be fully learned in all age groups. Depending on the capacity of the current age group, the scope of the standards may vary from year to year. It would be wrong to say that these ten standards divide the subjects of preschool mathematics into sub-groups that never cross because these subfields of mathematics are interconnected and whole. Processes are learned within content standards, and content is learned within process standards. For example, numbers appear in all areas of mathematics (NCTM, 2000). Numbers are a crucial concept (Kandır et al. 2010). Some aspects of data analysis are also covered in the measurement.

Patterns and functions are in the geometry. Reasoning, experimentation, problem-solving, and description are used in all content areas of mathematics (NCTM, 2000).

It is essential to acknowledge that preschool children have knowledge of informal mathematics and that this knowledge can be structured through conscious adults, peers, materials, interactions, and conscious opportunities. It is a fact that children have natural curiosity and enthusiasm for learning during the preschool period. This truly set out parents and educators can provide mathematical concepts and skills with a fun and exciting way to children (Charlesworth and Lind, 2013, p.6). Play is the most appropriate method in this sense.

Play

Play is the child's work, and it is essential for the child's development (Mcnamee and Bailey, 2010). In early childhood, play can be used as a method, and it is a way of making life meaning for children. For this reason, play can be used to give children many concepts, and play has an important role in children's life to develop a positive attitude towards mathematics and realize that they can use mathematics in daily life.

The play has many benefits for the child. Children become conscious during the play process. They learn to think, keep in mind, and solve problems. The play provides opportunities for children to experience their thoughts and attitudes about the world in which they live (Mcnamee and Bailey, 2010).

The play supports the child to learn mathematical concepts with fun and increases his sensitivity to mathematics. Abstract mathematics concepts can only be embodied by play (Boz, 2019). The critical thing in this process is that the preschool teacher provides the necessary educational materials and environment to the children. A curious environment and materials that support children's problem-solving skills will enable the child to learn with fun (NAEYC- The National Association for the Education of Young Children). Also, NCTM emphasizes that play is a way to enrich children's experiences in mathematics education.

Play and Math

Many studies show that play-based mathematics education applied to preschool children positively affects academic achievement (Boz, 2019. During play children can develop their arithmetic and math skills, they can learn to work together and also show a high motivation to attend and continue to the learning process (Stebler, Vogt, Wolf, Hauser and Rechsteiner, 2013). In addition, play-based learning like numeracy plays may have a positive contribution to later attitudes towards math, technology, engineering, and science activities (Clerkin, and Gilligan, 2018).

Children use mathematics in their plays. For example, they use mathematics when they say "I am the second," "It's your turn after me" or "You have done three times, but I have done less. Mathematics is not just "5 + 8". It is collecting, classifying and recording data, seeing and solving the problem, generating ideas, establishing relationships, making a trial error, and developing strategies. Children already use them in their plays. For example, according to Nath and Szücs (2014), construction play with Lego has a positive relationship with mathematics performance. The reason for that children uses visuospatial short-term and working memory while they are playing construction play, and it is also related to their mathematical abilities. In addition to that, divergent thinking, nonverbal reasoning abilities, and mental imagery skills which are also related with the math skills are developed with Lego play (Pirrone, Tienken, Pagano, and Di Nuovo, 2018).

Adults can bring mathematics into everyday life, by just letting them play or playing together. It is possible to find mathematical contents in many plays from traditional plays to mind plays such as counting up to fifty in hide-and-seek and matching objects and numbers in 'Aç Kapıyı Bezirgan Başı'(one of the traditional Turkish plays). According to Özdoğan (2011), learning math could be difficult for children in the early childhood period and teachers could create an environment where children understand and make connections between math and realistic problems. To provide that environment and construct their mathematical abilities, play is an effective way because it allows hands-on experiences.

The Role of the Teacher in Play Supported Mathematics Teaching in Early Childhood

Early childhood is a process in which children actively acquire basic concepts and learn necessary skills. Children's developmental domains are affected during this period (Heffelfinger and Mrakotsky, 2006). Children construct concepts through new discoveries.

For young children, the learning process is continuous, and in this process, they continue to learn in interaction with different objects and situations, parents, and other individuals. The play has an essential role in this process. Thanks to play, children are in effective communication with their environment, so learning takes place in the natural process.

Mathematics has great importance in terms of analyzing and making sense of the world. Defining numbers, shapes, and space mathematically gives people a systematic view of the world. Children's positive attitude towards mathematics education is related to early childhood education and adult support during this process. Children can learn mathematical concepts from their environment, and from people, they interact with socially. The children then construct the information for themselves and make it useful.

Different play activities can be used.A study shows that teacher use teacher-directed play activities instead of guided play while teaching math. On the other hand, guided play is a more optimal method (Wickstrom, Pyle, and DeLuca, 2019). Salomonsen (2019), argue that child-initiated or adult-initiated methods can be used to teach math, but they should be deliberate and planned while combining the children's play and everyday experiences.

In the Magnusson and Pramling's study (2018), the teacher uses a child's drawing which called as Numberland, and it creates an opportunity and playful environment to talk with children about math which s/he familiar with. Educators support the idea that using play as a teaching method meets various needs of children after using the card and board games as a play-based approach for teaching math (Vogt, Hauser, Stebler, Rechsteiner and Urech, 2018).

In addition to the positive effect of playful math activities on children, teachers also gain self-confidence through the process. Children's positive response to activities, seeing their evolving math knowledge also encourages teachers to use these activities more often. Teachers think children develop their math and science knowledge and competency through play (Anders and Rossbach, 2015; Cohrssen, Church and Tayler, 2016; Fernández-Oliveras and Oliveras, 2014; Sancar-Tokmak, 2015).

The Role of the Teacher in Classroom Planning in Play Supported Mathematics Teaching in Early Childhood

Children's daily experiences are ideal opportunities in early childhood mathematics education. Children can become aware of the mathematics in life by making use of everyday experiences at

home, in playgrounds, in early childhood educational institutions, on a cultural trip or holiday. Block games, sociodramatic play, table games, scientific activities, jigsaws, and reading books can be suitable times for timely math learning opportunities (Bradekamp, 2015).

When planning mathematics activities, concepts should be gained through games and active activities instead of being supported by worksheets. It is thought that the children who were in early childhood, who were asked to sit at a quiet and calm desk, with the figures on paper, limited the curiosity and excitement of the children (Uyanık and Kandır, 2010). By nature, children want to be all the time, and therefore, they try to recognize objects by experimenting and feeling objects. The concepts related to mathematics should be gained to children through daily life experiences, games, and entertaining activities (Jenkins and Eliason, 2003). In this way, learning for children is becoming more permanent.

One of the issues that have been emphasized in the studies on quality in preschool education is teacher-child communication. In order to provide a qualified education, the teacher should be a self-renewing, creative, researcher, and flexible person (Kandır, İnal, and Özbey, 2010).

For teachers, being ready for mathematics education is very important, but sometimes it can be difficult. In general, to teach mathematics, it is necessary to have a strong mathematical and pedagogical background. NCTM, issued by the Professional Standards for Teaching Mathematics (1991) also made the following emphasis for teachers; 'The teacher should strive to provide an in-depth understanding of mathematical concepts and principles, and to make connections between mathematical issues or other disciplines of mathematics.'

The Role of the Teacher in Communication with Family in Play Supported Mathematics Teaching in Early Childhood

Nowadays, families aim to have a say about children's educational processes and support their children. However, in this process, sometimes there are wrongs that they know correctly. Particularly anxiety about failure in academic skills can also affect family communication. At this point, family - school cooperation gains importance. Starting from early childhood, the family must interact with the school throughout the child's education process and try to fulfill its duties.

Taking into account the characteristics of the family, cooperation with the family should be made, and the family should be informed about the child during the education process. The teacher should inform the parents about the importance of mathematics and how much it is used in daily life and guide the parents in structuring their child's success and attitude towards mathematics together (Güven and Çolak, 2019).

Different socioeconomic backgrounds could be a challenge for teachers to arrange learning environment because of the lack of previous knowledge. In that point, they may benefit from parents' support and parent involvement. Thanks to play, this needed support could be provided. Ramani and Scalise (2018) suggest that children can get numerical knowledge with the endorsement of home play activities which color and shape matching card games. It has a positive effect on both children's mathematical knowledge and parent's attitudes towards teaching math.

As a result, children experience a variety of math concepts in their lives and play activities are one of the opportunities which provide these kinds of experience. In this process, teachers' role is very important to create an environment which is rich in terms of math activities supported by play. There are math activities supported with guided play included probability, mathematical operations, algebra, geometry, measurement, and data analysis.

Activity Examples

Activity Example 1

Activity Subject: Geometrical shapes

Age Level: 60-72 Month

Activity Purpose: Create geometric shapes using their bodies and interiorize shapes easier

Materials: Rope

Learning Process: The teacher hides 3 envelopes includes triangles, 4 envelopes includes squares, 4 envelopes includes rectangles, and 5 or more envelopes includes circles in different parts of the classroom. She/he asks every child to find an envelope.Children who find the same shape become a group. The teacher gives each group a large rope attached to the tip. He asks the children to go into the rope to form the shape which they found. Children form shapes using the rope and their bodies. The activity continues until all children experience each shape.

Assessment: Children can create geometric shapes themselves by lying on the ground.All children can form the same shape at the same time, or they can be divided into small groups to form different shapes.

Activity Example 2

Activity Subject: Numbers

Age Level: 60-72 Month

Activity Purpose: Learning the quantity of numbers by seeing and hearing and understanding their writing

Materials: Balloon, bell

Learning Process: The teacher writes numbers with magic marker on the balloons he inflates. For example, she/he writes 1 on 1 balloon, 2 on 2 balloons, 3 on 3 balloons and so on. The balloons can be increased according to the numbers targeted to teach. The balloons are dropped into the classroom, and the music opens. Children dance with balloons. After a while, the teacher stops the music and rings the bell. The number of times the teacher rings the bell, and the children find the balloon with that number. For example, if the teacher rings the bell 3 times, the children will find 3 balloons which are written 3 on them. The balloons found are brought up and discussed on the writing of the numbers and quantity the number 3 represents. When the teacher rings the bell 4 times, the children try to find 4 balloons which are written 4 on them. The play continues like that.

Assessment: Children can make double-foot jumps by the number of rings the teacher rings. It is played in small groups in turn and the child who makes a mistake get out of the play. In the end, the winners of all groups play the game.

Activity Example 3

Activity Subject: Quantity, heavy- light

Age Level: 60-72 Month

Activity Purpose: Learning the concepts of quantity and heavy- light by embodying them

Materials: Two buckets and two plastic flowers, two small glasses, a jug full of water, a hanger

Learning Process: The teacher brings 2 buckets to the class. In these buckets, there are artificial flowers in plastic pots. The teacher says the flowers need water to grow and get out of the buckets. By spilling water in these buckets, the plastic pots can be risen. However, there are rules for this. There is a path which children follow to put water in the bucket. It is a path that consists of thin, long, straight and zigzag lines and obstacles need to be passed over and under. (Obstacles in the path can be changed.)The teacher puts two buckets on a hanger and holds by sitting at the end of the road. The children are divided into two groups and are in turn. The teacher gives each group a small cup. The children fill the glass with water and follow the straight and zigzag line and cross the other obstacles to reach the bucket without pouring water. The play continues until the first group's flower goes up. When the flower goes up, there's more water in it. The side of the hanger carrying more water will also collapse downwards. These processes are discussed with children. The concept of quantity is discussed.

Assessment: Waters can be weighed by using scales and evaluated

Activity Example 4

Activity Subject: Graphic

Age Level: 60-72 Month

Activity Purpose: Create graphic, make comparisons between groups, comment on quantities and understand the quantities by counting

Materials: Rabbit puppet, a blue garbage bag or cardboard, fruit images, a stick that can be used as a fishing rod, small magnets, a cardboard to create graphics

Learning Process: Teacher shows children a small rabbit puppet. She/he says that this rabbit went to the market but couldn't carry his bags on the way back and dropped what he took into a lake. She/he also asks for help because he cannot collect the droppings from the lake. (The teacher puts images of different fruits on a blue garbage bag and tells them that they are fruits which have fallen in the lake. A magnet is stuck behind each fruit image.) The teacher also says that after collecting the fruits, it is necessary to create a graphic by placing the same fruits one after the other, so that the rabbit can see if there are any missing fruits. The teacher gives the children a stick similar to a fishing line and a magnet attached to the end of the rope of the stick to collect the fruits.Every child comes in turn. First, it catches a fruit from a point at a distance from the lake. It pastes the captured fruit under the same fruit picture in the prepared cardboard. In this way, after all the fruits have been collected, the fruits are counted together with the rabbit and talk about which fruit is there, which is more and which is less.

Assessment: Children can find the most favorite fruit in the classroom by drawing their favorite fruits and creating graphics**.**

Activity Example 5

Activity Subject: Matching - Grouping - Pattern

Age Level: 60-72 Months

Activity Purpose: Matching the same color objects, making grouping and forming a triple pattern

Materials: Egg parcels painted in yellow, red, and blue colors and eggs prepared in those colors, a box looking like a sales box, round cartons in yellow, red and blue colors

Learning Process: The teacher prepares eggs from cardboard in yellow, red and blue colors and egg boxes of the same colors. Besides, s/he forms a path of round cardboard stones in yellow, red and blue colors. S/he puts the yellow, red and blue eggs in a mixed form at the end of the road and also puts yellow, red and blue egg parcels on the sides of the eggs. After that, s/he tells the children that these eggs have fallen from the parcels and they should be put in the correct color parcels according to their color. In doing so, s/he tells children which color they will take the egg, they must jump from the stones of that color. For example, the child who will put the yellow egg in the yellow box jumps from the yellow stones and reaches the yellow egg. After all the eggs are put the parcel according to color, the eggs must be arranged on the sales box to be sold. The teacher prepares a sales box. There are eggs prepared in yellow, red, and blue color order in this box. In this order, they formed a triple pattern. The children are told that the eggs must be arranged in order to color on the sales box to be sold. The children come in sequence, take the egg from the parcel and place it on the sales box, paying attention to the pattern.

Assessment: Children can make a wristband with the same color beads and practice pattern concept.

Activity Example 6

Activity Subject: Graphic - Length - Number

Age Level: 60-72 Months

Activity Purpose: Making graph according to mathematical rules objects by measuring lengths of the objects.

Materials: Papers cut in the form of cucumbers with different length, baskets, stone-shaped papers, ribbon, cardboard

Learning Process: Before the activity, the teacher puts the papers in the form of cucumbers on the ground and surrounds it. After that s/he says that this is a field.They have to collect the cucumbers grown in the field to help the old farmer.However, there is an area with different size stones and swamps on the way to the field.To enter the field, children have to jump over the stones and walk in the swamp.Afterward, they put 3 cucumbers in their baskets (which can be changed according to the number to be taught) and return the same way.After the cucumbers are collected, the children measure the cucumbers with ribbon and cut the ribbon according to cucumbers' size. Ribbons which cut are compared, and they make a graph according to their size.

Assessment: They can talk about the graph and compare their other toys' length.

Activity Example 7

Activity Subject: Time Concept (before-after) – Ordering

Age level: 60-72 Months

Activity Purpose: To teach the concept of before and after using playing cards.

Materials: Playing cards on which the stages of the formation of the butterfly are shown visually (stages: egg, caterpillar, cocoon, small butterfly, large butterfly)

Learning Process: The teacher distributes the cards to the children with images of the formation stages of the butterfly.Children order the formation stages of the butterfly on the cards.In these stages, it is first mentioned that there is an egg, then a caterpillar, then the caterpillar becomes a cocoon, then a small butterfly emerges from the cocoon, and in the final stage, it is a large butterfly.

In the meantime, the children are discussed before and after concept, and this concept is emphasized during the activity.

Assessment: Children may be asked to act out the formation stages of the butterfly. Afterward, the concept can be reinforced with children by asking questions about their own lives during the day. For instance, what do you do after waking up? What do you do before you eat? etc.

Activity Example 8

Activity Subject: Grouping – Shape - Size

Age level: 60-72 Months

Activity Purpose: Developing children divergent thinking and imaginary mental skills which support their mathematical skills

Materials: Wooden blocks, cardboard boxes with different sizes, puppets, variety of loose materials (optional)

Learning Process: The teacher distributes the blocks into the class before the activity. S/He tells children that they will go to the land of puppets together.As they go on the road, s/he draws their attention to the blocks and talk about the shapes of the blocks. Then when they come to the entrance of the land of puppets, they encounter a puppet.The puppet says that s/he goes out to walk around, but the bridge is gone, so they have to build a bridge to enter the land. They decide to use blocks to build the bridge. The children collect the blocks according to their shape and form a separate group with collected blocks. Then the teacher brings the loose materials as auxiliary materials.Together bridge is built, and they enter the land of puppets. They meet other puppets in the country, and the teacher tells a story using puppets.

Assessment: In this process, children draw the bridge, and they talk about the shapes they use.

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