

## Investigation of Counting Skills of Pre-School Children

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### Abstract

The research aims at examining the counting skills of children in the preschool period. For this purpose, this study has been planned according to the “survey model”. The study group of the research is comprised of 108 children with ages between 60th-72nd months, who attend kindergartens. The “Counting Skills Test” has been used, which has been developed by the researcher as a data gathering tool. The research concluded that the preschool children possessed good levels in the skills of “rhythmic counting, stable order, counting the next number, abstraction, cardinal number and recognizing numbers” and that they had no problems therewith.

**Keywords:** Education, Preschool, Mathematics, Counting Skills

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## INTRODUCTION

Pre-school mathematics education involves many concepts such as counting, measurement, graphics, estimation, probability, geometric shapes, temporal and spatial position. One of the concepts of mathematics that children should learn in pre-school is the number system. Counting is a complex skill that involves sorting numerals in the correct order, assigning each item in the set a numeral and counting each object only once (Arnas, 2006; Charlesworth and Lind, 2007; Van de Rijt and Van Luit, 1998). To help children better understand numbers, they are advised to count real objects, which forms their experience. Day activities for children should include songs, finger games and stories that involve counting and children should be accompanied during these activities. In young children, counting begins with rote counting (ability to recite the names of numbers by heart) and continues with logical counting (matching the name of each number with an object in a group in correct order). Even if they can count small numbers (one, two, three, four) consecutively using objects and say the last number as the answer to the question ‘How many?’, children cannot fully comprehend the numerical meaning of that number (National Association for the Education of Young Children [NAEYC], 2008). As they learn by counting objects in sets, children begin to make sense that numbers refer to quantities. They begin to use numbers to solve everyday problems, such as how many spoons they will need for a group or how many sides are there in a rectangle. When they start kindergarten, they need to be ready to associate numbers and groups. To fully and accurately count objects, the child should know the names of numbers in the correct order and be able to coordinate his/her eyes, hands, speech and memory (Charlesworth and Lind, 2007). Researchers conclude that finger counting plays an important role in young children’s making sense of mathematics. It has been established that using fingers for counting, comparison, and application in simple operations forms a basis for children to comprehend numbers up to 10 (Copley, 2000).

The National Council of Teachers of Mathematics (NCTM) (2000) focuses on the development of counting from rote counting toward logical counting. In addition, children are expected to learn about the relative position and magnitude of whole, ordinal and cardinal numbers and their connection with each other; develop a sense of whole numbers; and represent and use them in many ways. These expectations must be realized using real-world experiences and physical materials. Therefore, active learning environments, experiences and methods are needed for children in early childhood to develop the concepts and skills they will use in the future (Baroody and Ginsburg, 1990; Curtis, Okamoto and Marie-Weckbacker, 2009; Young-Loveridge, 2004). It is highly important for children to acquire counting skills in early age. This is because children who fail to acquire or fully comprehend this skill, which is the basis of mathematics, will have problems in later levels of education (Aunio, Hautamäk and Van Luit, 2005). Additionally, there are standards for ‘number and operations’ set by NCTM from pre-school through primary school grade 2. These standards are specified in Table 1.

**Table 1. NCTM Standards and indicators for pre-school through grade 2**

STANDARDS	INDICATORS
Understand numbers, ways of representing numbers, relationships among numbers, and number systems	Count with understanding and recognize ‘how many’ in sets of objects
	Use multiple models to develop initial understanding of place value and the base-ten number system
	Develop understanding of the relative position and magnitude of whole, ordinal, and cardinal numbers and their connections
	Develop a sense of whole numbers and represent and use them in flexible ways, including relating, composing, and decomposing numbers
	Connect number words and numerals to the quantities they represent, using various physical models and representations
	Understand and represent commonly used fractions such as $\frac{1}{2}$ and $\frac{1}{4}$
	Understand situations that entail multiplication and division, such as equal groupings of objects and sharing equally

In the pre-school curriculum, prepared by the Turkish Ministry of National Education (MoNe) (2013), the counting-related achievement, 'Count objects', has the following indicators: 'Count up/down rhythmically one by one, denote as many objects as represented by the specified number, tell how many objects are counted, tell the ordinal number and tell the number that comes before and after a number among numbers up to 10'. Therefore, the skills related to rhythmic counting, counting down saying the previous number, saying the next number and telling ordinal and cardinal numbers are included in the scope of this study. The counting principles, namely, stable-order principle, abstraction principle, subitizing and order-irrelevance principle, developed by Gelman and Gallistel (1986) and the counting on principle that requires an advanced cognitive level and is used in the addition operation, developed by Clements and Sarama (2009), are also included in the skills investigated as part of this study. These skills and principles are briefly described below.

**Rhythmic counting:** Rhythmic counting is a mechanical pronunciation of number words that children learn through imitation of adults (Güven, 2005). Rhythmic counting is a preliminary achievement for counting and is like singing for children (Aktaş-Arnas, 2012). Children first learn to count rhythmically with single-digit numbers. Rhythmic counting consists of reciting the names of numbers in order by rote and without any objects. Children first acquire the skill of rhythmic counting with single-digit numbers (such as 1, 2 and 3), followed by the ability to count objects (Arnas, 2006; Stock, Desoete and Roeyers, 2009).

**Counting on:** Counting on is a skill that children use in addition. Counting on requires a more advanced cognitive level. When the child is shown first a picture of four apples, followed by a picture of three more apples and asked how many apples there are, the child is expected to find the result not by starting from the beginning but by counting 5, 6 and 7 (Clements and Sarama, 2009).

**Counting down:** Compared with the skill of counting up, it is harder for children to acquire the ability to count down (Wynn, 1992). Counting down helps children comprehend the subtraction operation and get to know the number system better. Counting down is a skill that is also used by some children to solve subtraction problems. Children see counting down as an entertaining task, and they like to practice this topic and show their skills (Arnas, 2000; Sperry Smith, 2009).

**Stable-order principle:** It means the memorization of counting words used by adults in a certain order. In counting, it is the rule specifying that number words should be recited in a certain, stable order. In order for children to be able to count, they need to know the order of the number words (Gelman and Gallistel, 1978; Trust, 2005; Sperry Smith, 2009). The sound patterns children learn from children's songs in the nursery can also be considered a reflection of this principle. Through repetitions, children understand that that numbers have a stable order and they recognize that this is a principle that underlies counting (Haylock and Cockburn, 2014).

**Stating previous and next numbers:** For pre-school children stating the numbers that come after a specific number is harder than stating the numbers that precede a specific number. In other words, when the numbers before a number are recited and children are asked to state the number that follows them, they find it harder to answer, whereas when a number is said and children are asked to state the numbers following it, they find it easier to answer. After the age of four, children start comprehending the rule that the number following a specific number is greater (Güven, 2005).

**Abstraction principle:** This principle suggests that children should understand the rule that every countable object should be counted. For counting, it is not necessary for the objects in a set to be related to each other. The essential thing is that the items in the set should be countable. It does not matter what the counted object is; the process is exactly the same for children, animals, counting disks or fingers (Gelman and Gallistel, 1978; Haylock and Cockburn, 2014). Children should realize that the various toy farm animals, such as cows, chickens, and ducks, given to them do not have to be the same in order for them to count (Sperry Smith, 2009).

**Subitizing:** Children's ability to see instantly how many there are without counting when a set of objects is shown. With a small number of objects, children can realize how many there are without counting them. Subitizing as a shortcut to counting develops as a skill after learning counting. If a child can tell the number of items in a set without counting them, it can be said that he/she has begun to understand numbers. The rate of correct answers by children decreases as the quantities of the items involved increases and the items become more dispersed. Notably, counting by looking is more difficult than counting by touching (Clements, 1999; Le Corre et al., 2006). There are two forms of subitizing: perceptual and conceptual. Perceptual subitizing consists of determining the number of items in a group without actually counting them. Young children often learn to subitize up to four items perceptively. In other words, when a set of four items is shown, they can tell you that there are 'four' items without counting. Conceptual subitizing involves seeing number patterns within a set just like seeing larger dot patterns in a domino (Charlesworth and Lind, 2007).

**Order-Irrelevance Principle:** This principle states that the result will not change wherever you start counting unless other counting policies are violated. It is an understanding that the result will not be affected regardless of whether you start counting from the beginning or from the middle. In other words, children should be able to count regardless of how the set is sorted without being arranged side by side. Children face difficulties in learning this rule. Teachers may need to act as a model by guiding children when they are faced with difficulties and using concrete examples to show that the outcome will not change regardless of where they start. According to Gelman, three-year-old children cannot understand this rule, but four-year-old children can better understand it (Gelman and Gallistel, 1978; Güven, 2005).

**Ordinal numbers:** These numbers are used to specify the order or position of an item. They answer the question, 'Which is the order?' Ordinal numbers require the knowledge of ordering or sorting. Examples of the use of ordinal numbers include children using phrases such as 'Let the child in the fifth row come, or 'We live on the second floor' and four 5-year-old children competing among themselves and determining the winner and those who came second, third, fourth or last at the end of the race (Baroody, 2004; Buldu, 2010). Brannon and Van de Walle (2001) noted that children even at the age of two noticed numerical differences and ordinal characteristics of numbers up to six.

**Cardinal number principle:** According to this principle, children should realize that the most recent number that they say when counting the items in a set denotes the total number of items in the set. If a child can answer the question 'How many?', it can be said that he/she has comprehended the cardinal principle (Baroody, 2004). The cardinal principle requires having conceptual knowledge about the result of the counting process; children can recognize the cardinal characteristics of numbers at the age of three to four (Bruce and Threlfall, 2004; Fuson, Grandau and Sugiyama, 2001; Nye, Fluck and Buckley, 2001; Zur and Gelman, 2004).

**Numerals:** Children making sense of the symbols of numerals at first is one of the findings that indicate they have gained experience in counting numbers. In the age of five to six, children can count from 1 to 20 with the knowledge of their meaning and can state the number of items in a set, counting the items one by one. They can recognize the numerals from 1 to 10, say their names, and sort them in order (Metin, 1992). They understand their meanings later. Observations show that children usually first learn the numerals denoting their age. Instead of showing the numerals by typing them on paper, children should be provided concrete examples such as making numerals with play dough and drawing numerals on the ground. The use of paper and pen for teaching them numerals should not be hurried. It should be noted that the child's failure to write numerals properly does not mean that he/she does not know or understand numbers. It is difficult for the children who have not mastered fine motor skills or hand-eye coordination to write numerals properly (Taşkın, 2019).

Examination of literature reveals that numerous studies on counting have been conducted in Turkey. However, these studies focused on specific areas, such as knowledge of numbers (Aktaş-Arnas, Deretarla-Gül and Sığırtaç, 2003; Avcı, 2015; Bolat and Sığırtaç, 2006; Develi and Orbay,

2002; Olkun, Sapdan and Babacan-Özer, 2013; Önkol, 2012; Yılmaz, 2015) and counting principles (Çakır, 2013; Pekince and Dağlıoğlu, 2017), general math concepts (Erdoğan, 2006; Erdoğan and Baran, 2006; Taştepe and Temel, 2013) and covered primary school children (Olkun, Yeşilpınar and Kışla, 2014; Olkun et al., 2015) This study discusses many skills of pre-school children related to counting (rhythmic counting, counting down, counting on, stable order, telling the previous or next number, abstraction, order irrelevance, subitizing, ordinal numbers, cardinal numbers, saying the numerals), thus significantly contributing to literature. For this purpose, answers for the following questions were sought;

- 1) At what level are the rhythmic counting skills of children aged 60–72 months?
- 2) At what level are the counting down skills of children aged 60–72 months?
- 3) At what level are the counting on skills of children aged 60-72 months?
- 4) At what level is the stable-order principle of children aged 60-72 months?
- 5) At what level are the skills for telling the next number of children aged 60–72 months?
- 6) At what level are the skills for telling the previous number of children aged 60–72 months?
- 7) At what level are the skills related to the abstraction principle of children aged 60–72 months?
- 8) At what level are the skills of the order-irrelevance principle of children aged 60–72 months?
- 9) At what level are the subitizing skills of children aged 60–72 months?
- 10) At what level are the skills regarding the ordinal number principle of children aged 60–72 months?
- 11) At what level are the skills regarding the cardinal principle of children aged 60–72 months?
- 12) At what level are the skills for recognizing numerals of children aged 60–72 months?

## **METHOD**

### **Research model**

This study examines the counting skills of pre-school children. For this purpose, it is planned to fit the ‘survey model’. This research is a descriptive study that questions the current situation. In the descriptive survey model, answers to research problem(s) are sought by analyzing the data obtained from a large number of subjects and objects within a certain period (Arseven, 200; Karasar, 2010).

### **Study group**

The study group consisted of 108 children (48 girls and 60 boys), aged between 60 and 72 months, who attended pre-school institutions in Giresun Province, Turkey. The study group was selected using the proportional cluster sampling method, which is one of the cluster sampling methods. In proportional cluster sampling, the chance by which each sub-population is represented in the sample is representative of the proportions in the population (Karasar, 2010). To create a proportional cluster sample, the children in the study group were selected by creating sub-populations based on

‘upper’, ‘middle’ and ‘lower’ socio-economic levels, as the schools attended by the children in the population may differ in terms of research findings. Statistical information about parental socio-economic status prepared by Giresun Provincial Directorate of National Education was used with permission to determine the socio-economic level for this study. The children were selected evenly: 36 from upper, 36 from middle, and 36 from lower socio-economic level.

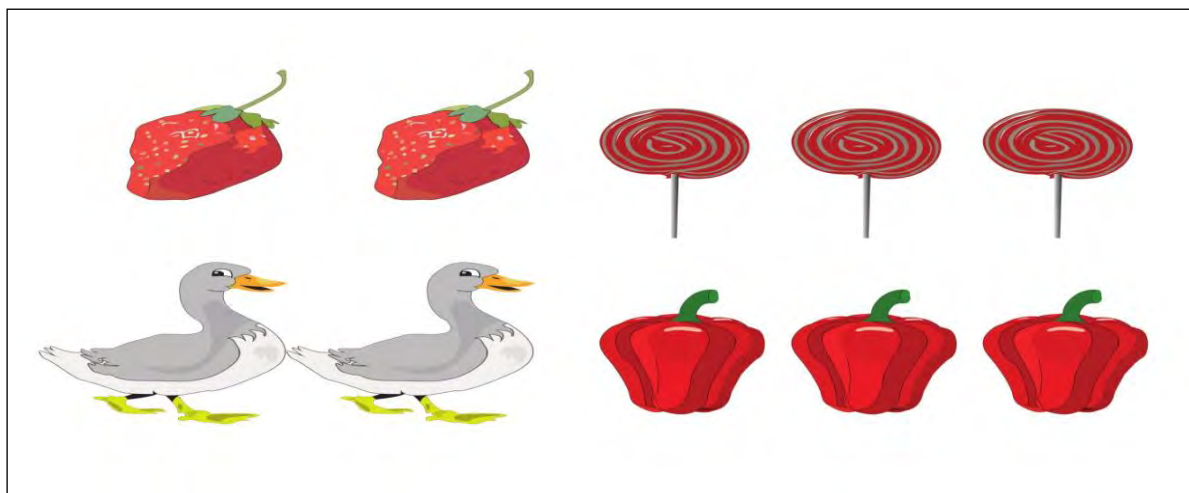
### Data collection tool

The ‘Counting Skills Test’ developed by the researcher was used as a data collection tool. The Counting Skills Test is designed to determine 12 counting-related skills of pre-schoolers, namely, ‘Rhythmic Counting’, ‘Counting Down’, ‘Counting On’, ‘Stable-Order Principle’, ‘Knowing the Next Number’, ‘Knowing the Previous Number’, ‘Abstraction Principle’, ‘Order-Irrelevance Principle’, ‘Subitizing’, ‘Ordinal Number’, ‘Cardinal Number’, and ‘Recognition of Numerals’. For each counting skill, 12 pictures were shown to children and they were asked to give their answers in accordance with the instructions of the researcher. The researcher marked the test in accordance with the answers given by the children.

**Table 2. Examples of how the Counting Skill Test was implemented**

Skill	Directive	Explanation	Observation
Abstraction principle (Figure 1)	Children are shown a picture containing 10 objects: two ducks, two strawberries, three candies, and three peppers. They are asked to tell what is in the picture.	It is said to the children: ‘We now have some objects in front of us. Can you tell me how many objects there are in the picture?’	( ) He/she counted all the objects correctly as 10. ( ) He/she gave wrong counts for all objects. ( ) He/she counted correctly by grouping the objects as two ducks, two strawberries, three candies, and three peppers. ( ) He/she counted erroneously by grouping the objects as two ducks, two strawberries, three candies, and three peppers.
Ordinal number (Figure 2)	Children are shown a picture containing 10 different objects. They are asked to state the ranking of the turtle and the dog.	The researcher says: ‘Now, you have some objects in front of you. I will ask you question about some objects’. He/she asks, ‘What is the ranking of the turtle?’ After the child answers it, he/she asks, ‘What is the ranking of the dog?’	( ) He/she answered both questions correctly. ( ) He/she answered correctly for the turtle in the 4th rank. ( ) He/she answered erroneously for the turtle in the 4th rank. ( ) He/she answered correctly for the dog in the 7th rank. ( ) He/she answered erroneously for the dog in the 7th rank. ( ) He/she answered both questions erroneously.

In the development of the Counting Skills Test, first, a literature survey was carried out and draft materials were created. Then, the pictures are prepared in accordance with the items. In addition to the researcher, one mathematics educator who studied mathematics in early childhood and one art educator worked together to prepare the pictures. After agreeing on the design, the pictures were prepared by the art educator. The draft test obtained after the materials and pictures were created was piloted with 30 children by the researcher, accompanied by a pre-school teacher and a fourth grader of pre-school teaching. The necessary revisions were made in accordance with the feedback obtained from the pilot test.



**Figure 1. Picture used to measure the abstraction skills of children**



**Figure 2. Picture used to measure the ordinal number skills**

To test the validity of the Counting Skills Test, content validity was used. The technique developed by Lawshe (1975) was employed for content validity. To this end, the following stages were followed: creation of a group of field experts, preparation of draft scale forms, obtaining expert opinions, obtaining content validity ratios related to the items, obtaining content validity indices related to the scale, and creation of the final form based on content validity ratios/index criteria. In Lawshe's method, opinions of minimum 5 and maximum 40 experts are needed. Expert opinions on each item are rated 'essential,' 'useful but not essential,' or 'not necessary' to the performance of the construct. In addition to content validity, expert opinions can also be rated for intelligibility of items, their appropriateness for the target audience, etc. Accordingly, expert opinions on any item are collected to obtain content validity ratios (CVR). CVRs are calculated by subtracting 1 from the ratio of the number of experts who mark an item 'essential' to the total number of experts expressing their opinions regarding that item (Yurdugül, 2005). In this study, the content validity was determined using the opinions of five faculty members who conducted research in mathematics education in early childhood. In the form given to the experts, they were asked to mark the items in the form as 'suitable', 'not suitable' or 'needs revision' and revise the items. The content validity of the items was statistically examined using Lawshe's method in accordance with the data received from the experts. Yurdugül (2005) stated that the CVR of any item must be minimum .99 to use that item based on

opinions from five experts. As a result of the statistical analysis, it was found that the CVR of each item of the 'Counting Skills Test' was greater than .99, and therefore, it was concluded that no item should be removed. However, some articles were revised according to the feedback from the experts, and the test form was finalized.

### **Data collection**

The research data were collected in May and June in the 2018–2019 academic year. Counting skills are included in the achievements starting from September or October. However, due to the cumulative characteristics of learning and the 'spiral' nature of the curriculum, teachers may return to achievements and indicators over and over again with different activities as needed throughout the process. Thus, achievements can be given and consolidated and their permanence can be ensured (MoNE 2013). For this reason, the data for this study were collected in May and June toward the end of the academic year.

Official permission was obtained from Giresun Provincial Directorate of National Education for the collection of data. In addition, written permission was obtained from the parents of the children who participated in the study group. The children who did not want to participate in the study or answer questions were not included in the study. Voluntary participation of the children was sought. The researcher was seated at a table with the child, and the researcher had the materials ready in advance. Before starting the test, the researcher made the necessary explanations and tried to comfort the children by chatting with them. Before starting the test, the researcher said to each child, 'Today, we will look at some pictures with you and talk about these pictures'. The children were called one by one using areas outside the classroom (such as guidance room, teachers' room, and director's room) to prevent children from being influenced by each other. Each child was given the same instruction. The answers of the children were not intervened in any way. If the child did not understand the question, the researcher repeated it once or twice, but the question was not repeated for any wrong answer. If the child said that he/she did not understand the question, the question was asked once again by the researcher. The test forms were numbered by writing the names of children on them. The duration of application of the test for each child was between 30 and 40 minutes.

### **Data analysis**

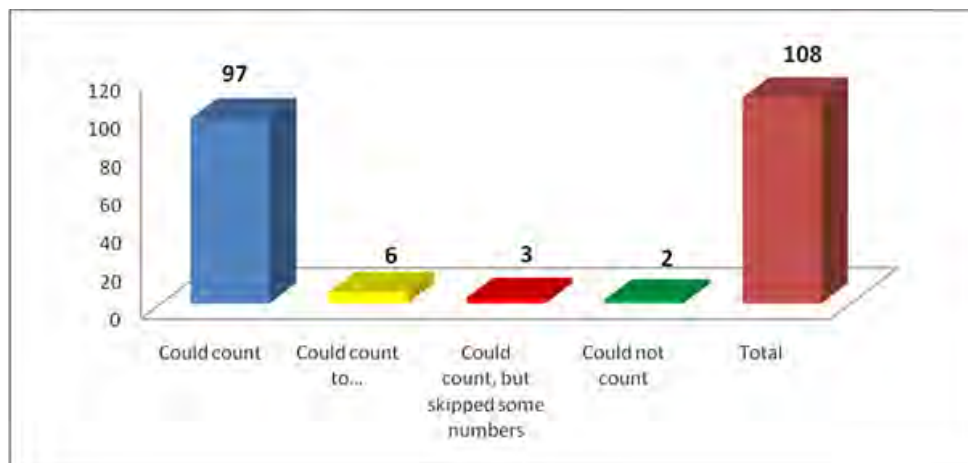
The data obtained were transferred by the researcher to the Microsoft Excel program, and the values of 'n' were calculated individually for each item in the scale form. The values obtained in this way were tabulated before being interpreted.

## **RESULTS**

**The results related to sub-problem 1:** At what level are the rhythmic counting skills of children aged 60–72 months?

In this section, the researcher said to the child, 'I can count from 1 to 10,' and counted from 1 to 3. Then, the researcher asked the child, 'Can you count to 10 now?' The distribution of the answers related to the children's rhythmic counting skills is given in Graph 1.



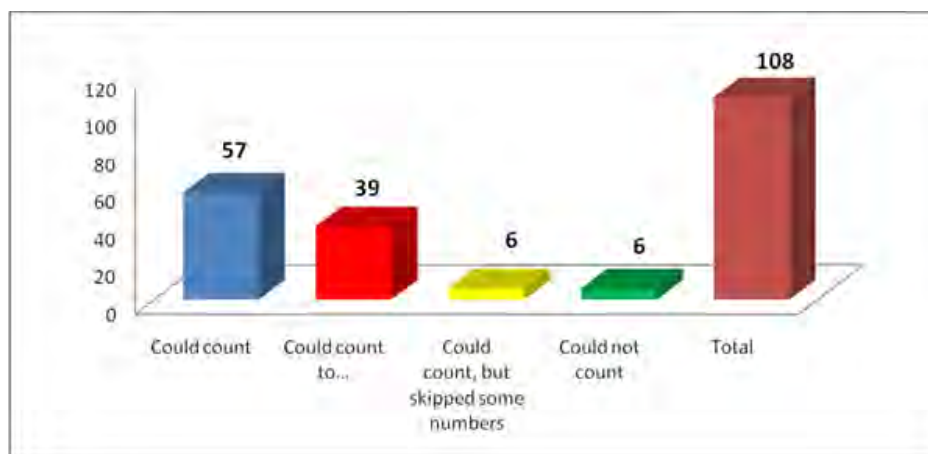


**Graph 1. Distribution of the children's rhythmic counting skills**

In Graph 1, the following results were obtained for the item related to ‘Children's rhythmic counting skills’: Could count (n = 97; 89.8%), Could count to... (n = 6; 5.5%), Could count, but skipped some numbers (n = 3; 2.7%), Could not count (n = 2; 1.8 %).

**The results related to sub-problem 2:** At what level are the counting down skills of children aged 60–72 months?

In this section, the investigator said to the child, ‘There are 10 birds in this picture. I can count these birds from 10 down to 1’ and counted from 10 down to 8. Then, the research asked the child, ‘Come on, can you count from 10 down to 1 now?’ The distribution of the answers related to the children's counting down skills is given in Graph 2.

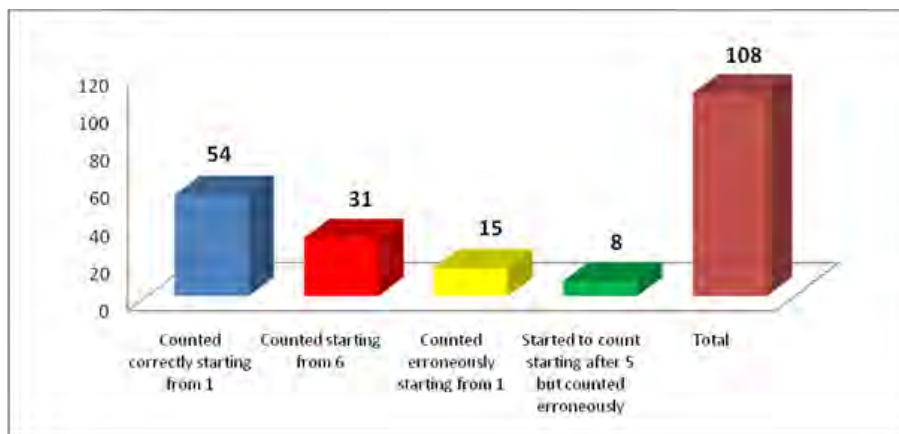


**Graph 2. Distribution of the children's counting down skills**

In Graph 2, the following results were obtained for the item related to ‘Children's counting down skills’: Could count (n=57; 52.7%), Could count down to ... (n=39; 36.1%), Could count, but skipped some numbers (n=6; 5.5%), and Could not count (n=6; 5.5%).

**The results related to sub-problem 3:** At what level are the counting on skills of children aged 60-72 months?

In this section, the researcher showed the child a picture of 10 ducks. Five ducks were covered and five were open. The child was first asked to count by showing five ducks. After the child finished counting, the researcher uncovered the other five ducks and asked, ‘Now, how many ducks are there?’ The distribution of the answers related to their counting on skills is given in Graph 3.

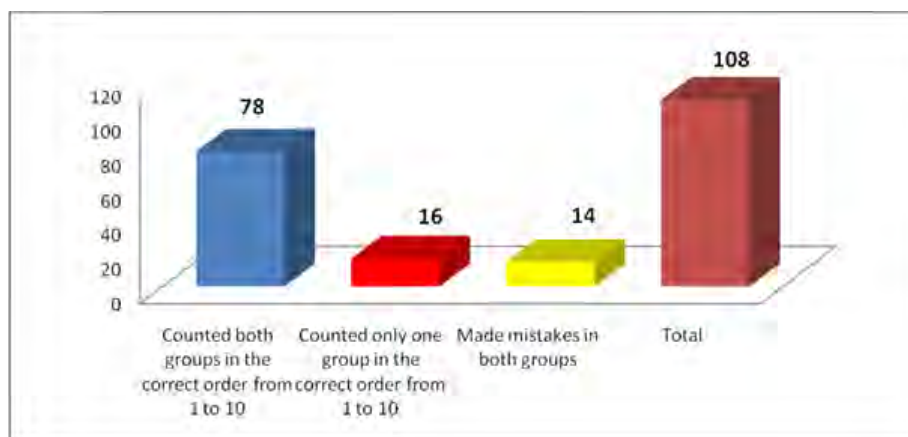


**Graph 3. Distribution of the children’s counting on skills**

In Graph 3, the following results were obtained for the item related to ‘Children’s counting on skills’: Counted correctly starting from 1 (n=54; 50%), Counted starting from 6 (n=31; 28.7%), Counted erroneously starting from 1 (n=15; 13.8%), and Started to count starting after 5 but counted erroneously (n=8; 7.4%).

**The results related to sub-problem 4:** At what level is the stable-order principle of children aged 60-72 months?

In this section, the researcher said to the child, ‘I’m going to show you some objects, lined up in different ways. Can you count the corns first and then the nuts?’ The distribution of the children’s answers regarding the stable-order principle is given in Graph 4.

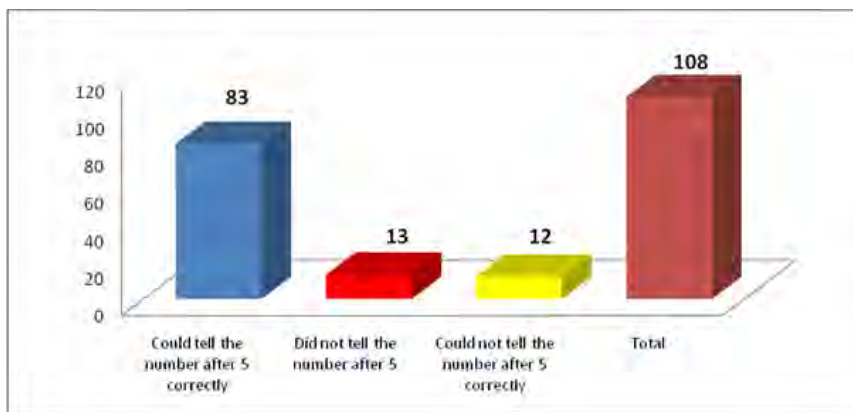


**Graph 4. Distribution of the children’s skills related to the stable-order principle**

In Graph 4, the following results were obtained for the item related to ‘Children’s skills related to the stable-order principle’: Counted both groups in the correct order from 1 to 10 (n=78; 72.2%), Counted only one group in the correct order from 1 to 10 (n=16; 14.8%), and Made mistakes in both groups (n=14; 12.9%).

**The results related to sub-problem 5:** At what level are the skills for telling the next number of children aged 60–72 months?

In this section, the researcher placed a picture containing dogs in front of the child and asked the child to count the dogs. After the child finished counting, the researcher said to the child, ‘Can you tell me which numbers comes after 5?’ The distribution of the answers related to the children's skills for telling the next number is given in Graph 5.

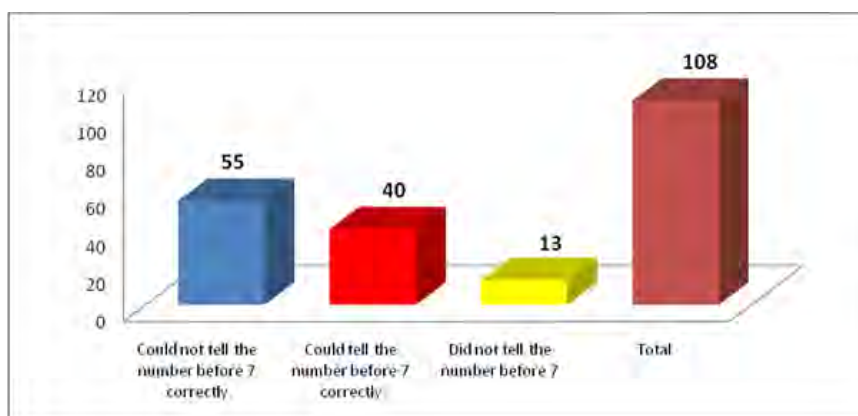


**Graph 5. Distribution of the children's skills for knowing the next number**

In Graph 5, the following results were obtained for the directive, ‘Can you tell me what comes after 5?’: Could tell the number after 5 correctly (n=83; 76.8%), Did not tell the number after 5 (n=13; 12.03%), and Could not tell the number after 5 correctly (n=12; 11.1%).

**The results related to sub-problem 6:** At what level are the skills for telling the previous number of children aged 60–72 months?

In this section, the researcher placed a picture containing turtles in front of the child and asked the child to count them. After the child finished counting the turtles, the researcher said to the child, ‘Can you tell me what number comes before 7?’ The distribution of the children's answers regarding the skills for telling the previous number is given in Graph 6.

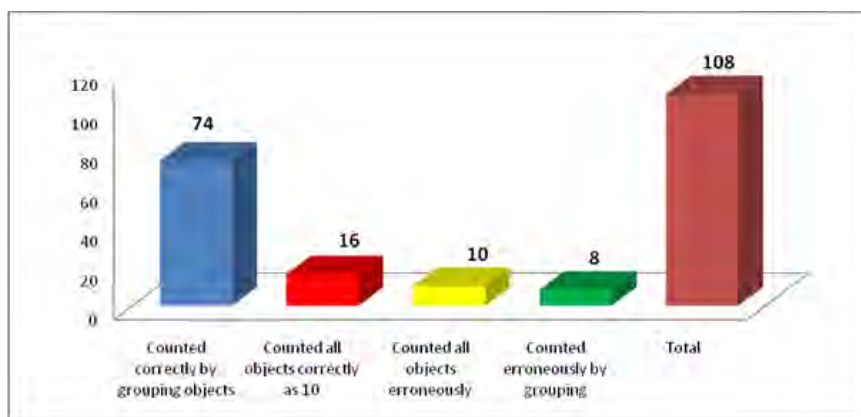


**Graph 6. Distribution of the children's skills for telling the previous number**

In Graph 6, the following results were obtained for the directive, ‘Can you tell me what number comes before 7?’: Could not tell the number before 7 correctly (n=55; 50.9%), Could tell the number before 7 correctly (n=40; 37.03%), and Did not tell the number before 7 (n=13; 12.03%).

**The results related to sub-problem 7:** At what level are the skills related to the abstraction principle of children aged 60–72 months?

In this section, the researcher placed a picture containing 10 objects, namely, two ducks, two strawberries, three candies, and three peppers, in front of the child and asked the child, ‘There are some objects in front of us. Can you tell me how many objects there are?’ The distribution of the answers related to the abstraction principle skills of the children is given in Graph 7.

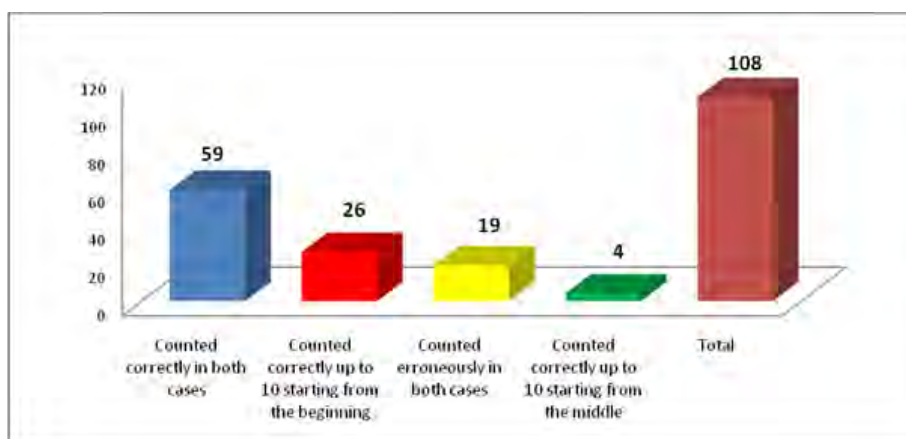


**Graph 7. Distribution of the children's abstraction principle skills**

In Graph 7, the following results were obtained for the directive, ‘Can you tell me how many objects there are?’: Counted correctly by grouping objects as two ducks, two strawberries, three candies, and three peppers ( $n=74$ ; 68.5%), Counted all objects correctly as 10 ( $n=16$ ; 14.8%), Counted all objects erroneously ( $n=10$ ; 9.2%), and Counted erroneously by grouping objects as two ducks, two strawberries, three candies, and three peppers ( $n=8$ ; 7.4%).

**The results related to sub-problem 8:** At what level are the skills of the order-irrelevance principle of children aged 60–72 months?

In this section, the researcher showed the child a picture of 10 dolphins lined up in order and asked the child to count first by starting from the beginning. After the child finished counting, the research said to the child, ‘Can you count again, this time starting from the fifth object?’ The distribution of the children's answers regarding the order-irrelevance principle skills is given in Graph 8.

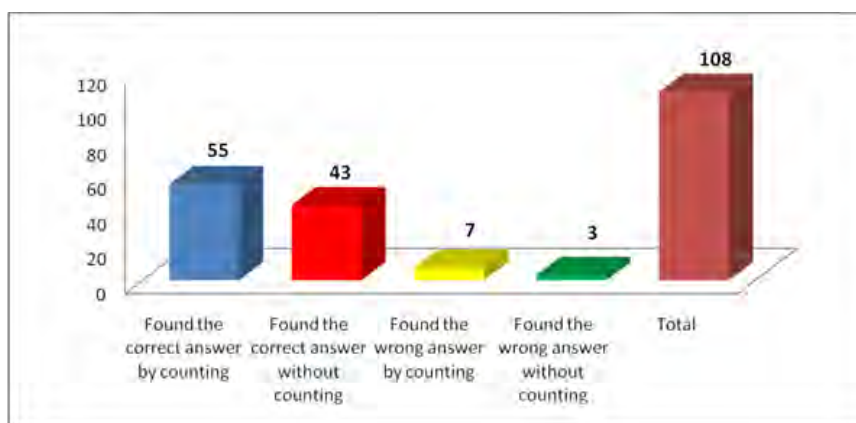


**Graph 8. Distribution of the skills of children regarding the order-irrelevance principle**

In Graph 8, the following results were obtained for the directive, ‘Can you count again, this time starting from the fifth object?’: Counted correctly in both cases (n=59; 54.6%), Counted correctly up to 10 starting from the beginning, but could not count to 10 starting from the middle (n=26; 24.1%), Counted erroneously in both cases (n=19; 17.5%), Counted correctly up to 10 starting from the middle, but could not count up to 10 starting from the beginning (n=4; 3.7%).

**The results related to sub-problem 9:** At what level are the subitizing skills of children aged 60–72 months?

In this section, the researcher put a picture of five strawberries in front of the child and said to the child, ‘Can you tell me how many objects there are without counting with your fingers?’ The distribution of the answers on the children's subitizing skills is given in Graph 9.

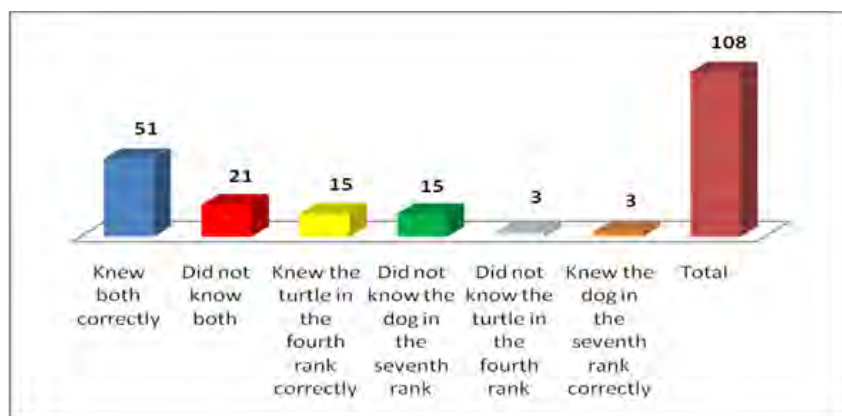


**Graph 9. Distribution of the children's subitizing skills**

In Graph 9, the following results were obtained for the directive, ‘Can you tell me how many objects there are?’: Found the correct answer by counting (n=55; 50.9%), Found the correct answer without counting (n=43; 39.8%), Found the wrong answer by counting (n=7; 6.4%), and Found the wrong answer without counting (n=3; 2.7%).

**The results related to sub-problem 10:** At what level are the skills regarding the ordinal number principle of children aged 60–72 months?

In this section, the researcher said to the child, ‘There are some objects in front of you. I'm going to ask you questions about some objects’. Then, the researcher asked, ‘What is the ranking of the turtle?’ After the child answered this question, the researcher asked, ‘What is the ranking of the dog?’ The distribution of answers related to children's skills regarding the ordinal number principle is given in Graph 10.

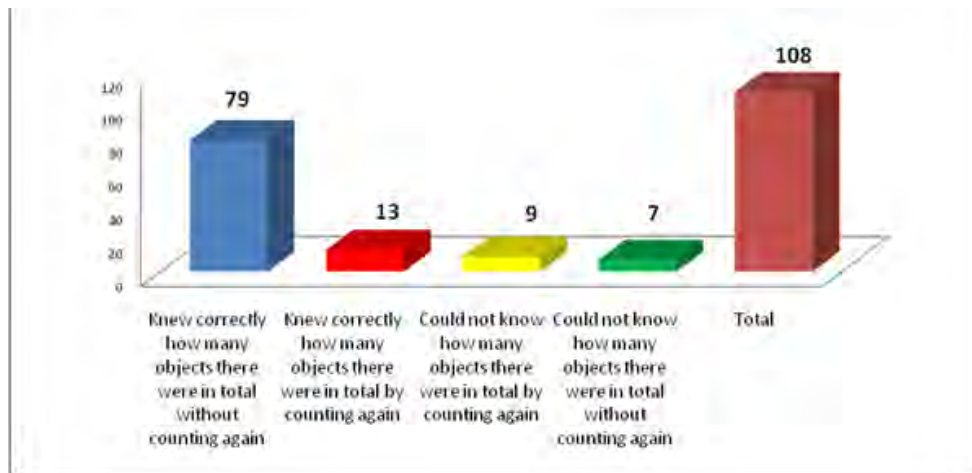


**Graph 10. Distribution of the children's skills regarding the ordinal number principle**

In Graph 10, the following results were obtained for the directive, ‘What is the ranking of objects?’: Knew both correctly (n=51; 47.2%), Did not know both (n=21; 19.4%), Knew the turtle in the fourth rank correctly (n=15; 13.8%), Did not know the dog in the seventh rank (n=15; 13.8%), Did not know the turtle in the fourth rank (n=3; 2.7%), and Knew the dog in the seventh rank correctly (n=3; 2.7%).

**The results related to sub-problem 11:** At what level are the skills regarding the cardinal principle of children aged 60–72 months?

In this section, the researcher put a picture of pears in front of the child and said, ‘There are pictures of pears in front of you. I want you to count these pears’. After the child finished the counting process, the researcher asked, ‘Can you tell me how many pears there are?’ The distribution of the answers related to children’s skills regarding the cardinal principle is given in Graph 11.

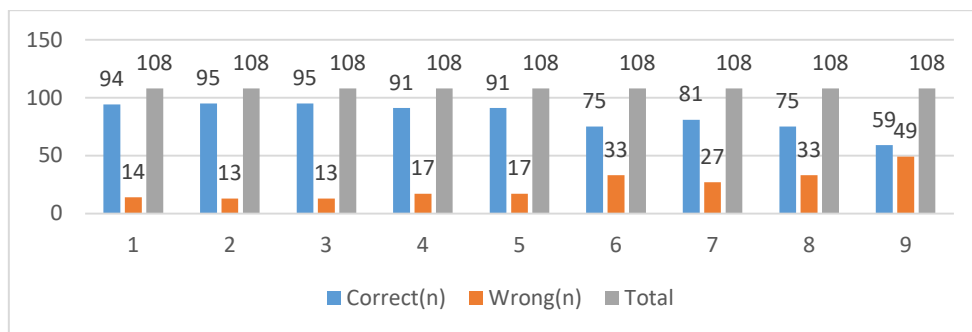


**Graph 11. Distribution of the children's skills regarding the cardinal principle**

In Graph 11, the following results were obtained for the directive, ‘How many pears are there?’: Knew correctly how many objects there were in total without counting again (n=79; 73.1%), Knew correctly how many objects there were in total by counting again (n=13; 12.03%), Could not know how many objects there were in total by counting again (n=9; 8.3%), and Could not know how many objects there were in total without counting again (n=7; 6.4%).

**The results related to sub-problem 12:** At what level are the skills for recognizing numerals of children aged 60–72 months?

In this section, the researcher showed a picture containing numerals 1 to 9 to the child and asked the name of each numeral in mixed order. The distribution of the answers related to children’s skills for recognizing numerals is given in Graph 12.



**Graph 12. Distribution of the children's skills for recognizing numerals**

In Graph 12, the following results were obtained regarding 'Children's skills for recognizing numbers': Correct (n=94; 87.03%) and wrong (n=14; 12.9%) answers for numeral 1, Correct (n=95; 87.9%) and wrong (n=13; 12.03%) for numeral 2, Correct (n=95; 87.9%) and wrong (n=13; 12.03%) answers for numeral 3, Correct (n=91; 84.2%) and wrong (n=17; 15.7%) answers for numeral 4, Correct (n=91; 84.2%) and wrong (n=17; 15.7%) answers for numeral 5, Correct (n=75; 69.4%) and wrong (n=33; 30.5%) answers for numeral 6, Correct (n=81; 75%) and wrong (n=27; 25%) answers for numeral 7, Correct (n=75; 69.4%) and wrong (n=33; 30.5%) answers for numeral 8, and Correct (n=59; 54.6%) and wrong (n=49; 45.3%) answers for numeral 9.

## CONCLUSION AND DISCUSSION

The results of this study demonstrated that the skills of pre-schoolers for 'rhythmic counting, stable order, telling the next number, abstraction, cardinal numbers and recognizing the numerals' were at a good level and they did not have any problem regarding these skills. The study also found that these children were rather adept at rhythmic counting skills. When literature is examined, it is seen that rhythmic counting was reported to be among the first skills children acquire (Bruce and Threlfall, 2004; Olkun et al., 2014; Sarnecka and Carey, 2008). However, the fact that children can count rhythmically up to 10 does not mean that they have mastered the counting skill. Similarly to the results of this study, Pekince and Dağlıoğlu (2017) found that the children were successful regarding stable order (83.1%), cardinal (74.4%) and abstraction (60.8%) principles. The results of the study Baroody conducted with children aged 4 years and Develi and Orbay (2002) with children aged 4–6 years demonstrated that the majority of the children successfully understood cardinal numbers. Likewise, the children's skills related to the stable-order principle were satisfactory. In their study with primary school first graders, Olkun et al., (2014) found that some of the children acquired the stable-order principle more quickly than the cardinal principle. However, their skills for 'counting down, counting on, telling the previous number, order irrelevance, subitizing and ordinal numbers' were not satisfactory and they had problems in those skills. Literature suggests that different materials and techniques should be used to support the development of counting skills. It can be argued that these results may be due to lack of use of special materials for counting skills in pre-school education institutions in Turkey. Therefore, active learning environments, materials, books and gamification methods are needed to support pre-schoolers in developing the concepts and skills of mathematics that they will use in the future (Baroody and Ginsburg, 1990; Curtis, Okamoto and Marie-Weckbacker, 2009; Young-Loveridge, 2004). This study revealed that the children were not good at the order-irrelevance principle. Stock, Desoete and Roeyers (2009) indicated that the order-insignificance principle is an essential counting skill along with the one-one-one and stable-order principles. Similarly, the results of this study demonstrated that the children were not successful in terms of their skills for counting on. However, counting on is a skill that children use particularly in addition. Counting on requires a more advanced cognitive level. When a pre-schooler is shown a picture of four apples and then three more apples and asked to tell how many apples there are, the child is expected to reach the result by counting 5, 6, and 7 (Clements and Sarama, 2009).

In this study, the children were not successful in terms of their skills for telling the previous number. Literature reports that children find it harder to learn numbers before a number than the number that comes after a number. In this regard, it can be said that the results of this study were similar to those reported in literature (Güven, 2005). This study also found that the children were not good at in their counting down skills. When the literature is examined, it is seen that the skills for countdown is harder to acquire than the skills for counting up. Nevertheless, the failure to acquire the counting down skill may adversely affect children's future math skills. Children learn that counting does not always start with 1, counting can go up or down, and counting down is a basis for the acquisition of subtraction skill (Hudson and Miller, 2006; Reys et al., 2012; Wynn, 1992).

In this study, it was observed that the children did not fully comprehend the ordinal numbers although it is one of the important counting skills. However, literature reported that pre-schoolers could acquire this skill. Brannon and Van de Walle (2001) noted that even at the age of two, children could recognize numerical differences and ordinal characteristics of the numbers. In children aged five years, sequencing concepts such as ‘first, second, next, and last’ begin to develop (Geist, 2001; NAEYC, 2008). In this study, it was also found that the children’s subitizing skills were not satisfactory. Young children often learn to subitize up to four items perceptively. In other words, when a group of four items is shown, they can tell you that there are ‘four’ items without counting (Charlesworth and Lind, 2007). In light of this information, it can be said that the children failed to acquire many counting skills mentioned in MoNE’s pre-school curriculum (2013). Therefore, it is recommended that children’s achievements should be evaluated closely and support should be provided for the achievement not acquired. In addition, teachers and pre-service teachers should be provided concrete examples about how to conduct activities related to counting skills and teachers should be encouraged to include activities related to all counting skills and use well-defined materials, methods, and techniques. Furthermore, experimental studies should be conducted concerning the shortcomings in the counting skills of children revealed in this study.

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