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Mental images of 48–72-month-old children about the concept of mathematics[1]

48-72 aylık çocukların matematik kavramına ilişkin sahip oldukları zihinsel imgeleri

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Abstract: This research aims to determine the mental images of the 48-72 month-old children attending pre-school education regarding mathematics by using the metaphor technique. This qualitative research was designed in the "phenomenology" model. In order to reveal the metaphors they have about the concept of "mathematics" to the children participating in the research, "What do you think mathematics looks like? Why?" and "If math was a color, what color do you think it would be? Why?" questions were asked and the answers were noted. The answers received from these interviews constitute the primary data source of the research. The data were analyzed by creating codes and categories. As a result of the research, it has been observed that even in the pre-school period, where learning experiences should be presented through play, children symbolize mathematics mostly with paper and pencil. It was also noted that children created metaphors reflecting fear and hate for mathematics.

Keywords: Perception, Attitude, Preschool Education, Children, Mathematics

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Öz: Bu araştırmanın amacı okul öncesi eğitime devam eden 48-72 aylık çocukların matematik kavramına ilişkin sahip oldukları zihinsel imgeleri metafor tekniği kullanarak tespit etmektir. Nitel olarak gerçekleştirilen bu araştırma "olgubilim" modelinde tasarlanmıştır. Araştırmaya katılan çocuklara "matematik" kavramına ilişkin sahip oldukları metaforları ortaya çıkarmak amacıyla "Matematik sence neye benzer? Neden?" ve "Matematik bir renk olsaydı sence hangi renk olurdu? Neden?" soruları sorulmuş ve cevapları not edilmiştir. Bu görüşmelerden alınan yanıtlar araştırmanın temel veri kaynağını oluşturmaktadır. Veriler kod ve kategoriler oluşturularak analiz edilmiştir. Araştırma neticesinde; öğrenme deneyimlerinin oyunlaştırılarak sunulması gereken okul öncesi dönemde dahi çocukların matematiği en çok kağıt ve kaleme ile sembolize ettikleri görülmüştür. Ayrıca çocukların matematiğe yönelik korku ve nefret unsurları içeren metaforlar oluşturdukları da dikkat çekmiştir.

Anahtar Kelimeler: Algı, Tutum, Okul Öncesi Eğitim, Çocuklar, Matematik

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INTRODUCTION

Preschool years cover a period when children go through quite intense learning experiences and lay the foundations of knowledge, attitudes and behaviors that they will have in the future. Children's mental worlds and life perspectives are shaped to a considerable extent in this period. Although mathematics seems to be a concept of advanced ages, it is necessary that its foundations are laid solidly in the preschool period. There is a significant relationship between preschool education and children's mathematical skills (Unutkan, 2007). Early math skills also predict reading, mathematics and science achievement from kindergarten to eighth grade (Claessen & Engel, 2013). In studies carried out in this context, mathematical skills in the preschool period have been found to be a strong predictor of subsequent achievement (Duncan et al., 2007; Claessens and Engels, 2013; Reyna and Brainerd, 2007; Watkins, Lei and Canivez, 2007). It is believed that the mathematical perceptions that children construct during the preschool period influences their attitudes and achievement towards mathematics lessons in subsequent educational stages. Research on mathematics carried out in Turkey shows that there is a perception among students that mathematics is a difficult and unachievable lesson. Toluk-Uçar, Pişkin, Akkaş and Taşçı (2010) found in a study that students interpreted mathematics as an unloved lesson, a monster, calculations, numbers and operations. The studies presented above have shown that students at almost all educational levels have negative perceptions of mathematics. However, when the literature was examined, no studies were found to determine the mathematics perceptions of preschool-age children. However, determining the mathematics perceptions of children of this age group is very important for the identification of negative attitudes that are beginning to develop in this period and for the development of the necessary interventions to prevent problems — that may occur in early ages — from being carried on to older ages.

Metaphor As A Data Collection Instrument

Metaphors are the means by which individuals try to define objects, events taking place, and abstract concepts encountered in everyday life by establishing certain analogies (Cerit, 2008). Through metaphors, both adults and children convey to other people certain situations which they are not familiar with or cannot describe, what certain situations mean, and the concepts or the terminology about certain situations. Metaphors are useful resources for an individual to understand a newly encountered situation and to explain the individual's intrinsic thoughts. The reason for this is that, with the help of metaphors, the individual defines the situation that he does not know well by using another situation that he knows well. It becomes easier for the meaning —

attributed by the individual to the new situation — to manifest itself. Fundamentally, metaphors are a form of contemplation and vision (Morgan, 1998).

The use of metaphors in learning environments is very important in term of steering instructional applications and providing clues about children's worlds of thought. Regarding the value of metaphors, Shuell (1990) said, "If a picture is worth 1000 words, a metaphor is worth 1000 pictures, for a metaphor presents a mental framework for thinking about a phenomenon, while a picture presents only a static image." This suggests that metaphors have an important place especially for researchers who work on children and can be an effective form of assessment in children's learning experiences

Metaphors created by children play an important role in the development of attitudes towards mathematics in the long run. Mathematical images have a positive or negative effect on developing an attitude towards mathematics prospectively in the process of teaching and learning mathematics (Ma and Kishor, 1997; & Lakoff and Nunez, 2000). Mathematics anxiety can be caused by the feeling of discomfort experienced by the child when interacting with mathematics, resulting in a bad image of mathematics (Wood, 1988) or the feelings of tension, helplessness, and mental disorder that the person may have when they need to manipulate numbers and shapes (Richardson & Suinn, 1972; Tobias, 1978) develops. Math anxiety in the long term; It can create emotions such as liking / disliking mathematics, being happy / anxious, motivated / fearful (Hart, 1989; Wigfield & Meece, 1988).

When we consider the studies in which the concept of mathematics is examined using the metaphor method, we see that these studies have generally been conducted on teacher candidates (Carson, 2001; Güveli et al., 2011; Mahlios & Maxson, 1998; Ocak & Gündüz, 2016; Şahin, 2013; Uygun et al., 2016) and on elementary and middle school students (Gerez Cantimer, 2014; Güner, 2013; Saban, 2008; Şengül, Katrancı, Oflaz, 2011; Yetim Karaca & Ada, 2018). Güner (2013) has pointed out that studies carried out on the mathematics metaphor discuss the contexts of mathematics, mathematics education, mathematics learning and mathematics teaching perceptions of elementary school, high school and university students, teachers, lecturers and adults. Similar to this study, in a study, Emen and Aslan (2018) examined preschool children's metaphorical perceptions of science and mathematics.

Kaphesi (2014) reported the metaphors of the participants about mathematics through a questionnaire consisting of five open-ended questions in his research, which aimed to document the metaphors of third-year mathematics education students studying at 36 universities. Similarly, Demirkol and Ergin (2017); examined the perceptions of pre-service secondary school

mathematics teachers studying mathematics and mathematics teaching through metaphors and through which metaphors they perceived the concepts of mathematics and mathematics teaching and reported according to gender, age, class, department and other demographic characteristics. At the lower education level, Köse (2018) examined the effect of secondary school students' metaphorical perceptions of mathematics lessons and lesson teachers on success. Considering the studies conducted with primary school children, Keleş and Aslan (2016) identified mathematics metaphors by asking open-ended questions to 227 pre-service teachers studying in the preschool education department. Similarly, Çekirdekçi (2020) investigated the primary school fourth-grade students' perceptions of the "mathematics lesson" through metaphors and whether the main categories determined for the typical characteristics of metaphors differ according to gender. Finally, similar to the age group discussed in the current study, Guarnera et al. (2019) conducted a longitudinal study to evaluate whether mental imagery processes in preschool children (4-5 years) are predictive for math skills, writing and reading in the first years of primary school (6-7 years), conducted a design study. This study evaluated effective mental production, examination, and transformation processes to increase his children's mental imagery abilities.

The results of all these studies show that research carried out with the help of metaphors on mathematics and mathematics-related concepts mostly discuss preservice teachers, teachers, and elementary and high school students. Unlike the research investigating preschool children's metaphors about mathematics and science (Emen & Aslan, 2018), in this study, children were asked to generate a metaphor directly for mathematics, and they were asked why they generated it. In addition to this, preschool children were asked to liken mathematics to a color as a second metaphor in order to better express themselves in an abstract concept like mathematics and to reflect on their perceptions in depth.

From this viewpoint, the present study differs from other studies in terms of examining preschool-age children's perceptions of mathematics by using the metaphor technique. Although preschool education does not include mathematics lessons in the first sense that comes to mind, the preliminary skills that form the basis of the mathematical skills used in everyday life are taught to children during preschool education. For this reason, identifying children's perceptions of mathematics at early ages is important to be able to improve and change these perceptions in the positive direction. From this viewpoint, this study was carried out to determine the mental images (metaphors) of 48–72-month-old children who were receiving preschool education, about the concept of mathematics by using the metaphor technique. In this context, answers to the following questions were sought: "What are preschool children's metaphorical perceptions of 'mathematics?"

and "What are the reasons for the metaphors that preschool children produce against mathematics?"

METHOD

In this study —carried out primarily in a qualitative manner in line with the aim of the study — an attempt was made to identify the perceptions of mathematics of children who were studying at preschool education institutions as well as the meanings they attributed to mathematics. Metaphors were used when trying to reveal the children's perceptions of mathematics. Metaphors are forms of language offering a strong mental representation, a complete picture and a rich source of data to the researcher through their structures that transform complex phenomena into a simple and understandable form. Metaphors take their powers not only from their descriptive structures, but also from their clauses which explain the reasons for the analogies made. A metaphor study is a qualitative research method frequently used to describe existing events, phenomena and situations in social sciences (Yıldırım & Şimşek, 2005).

Sample

The sample consisted of 170 children — 82 females and 88 males — who were studying in 8 preschool classrooms in the Çankaya district of Ankara province, Turkey where a study had been carried out previously and the children had known the researchers, for the children to able to express themselves better and not feel like strangers.

Data Collection

Before the data was started to be collected, the permissions of the ethical commission and the Provincial Directorate of National Education were obtained. Then, by going to the relevant school directorate, the purpose of the research was explained and they were asked whether they would participate in the study or not. After obtaining permission from the school administration, informed consent forms were sent to the families. Appointments were made from the school directorate and teachers for the location and time to interview with children of the families who voluntarily participated in the study and signed the consent forms. It was aimed to ask the children who participated in the study the following two questions in order to reveal the metaphors they had about the concept of "mathematics": "Mathematics is like ... because ..." and "If mathematics were a color, it would be ... because ..." However, when the age group of the research sample was taken into consideration, in order for the children to easily understand the questions, the following two sets of questions were organized and asked to the children individually, and their answers were noted: (1) "What do you think mathematics is like? Why?" and (2) "If mathematics were a color,

which color do you think it would be? Why?" It took approximately 10 minutes to direct questions to each child and to listen to his or her answers (acquaintance, warm up, and questions). The answers received during these interviews made up the main source of data of the study.

Data Analysis

A total of 12 answers were removed from the questionnaire in both questions, including 8 answers which did not generate any metaphors, and 4 answers which had metaphors but were missing the reasons. Each question was then subjected to content analysis in itself. Analyses were carried out by creating codes and categories. The following procedure was completed when analyzing the data. In the coding and sorting phase, the metaphors generated by the children participating in the study were coded. Next, these metaphors were gathered based on their common characteristics.

In the sample metaphor image compilation phase, the metaphors generated by the participants were sorted in alphabetical order. The first version of the data was reviewed, and an example, which was believed to represent each metaphor well, was selected from among children's statements. These examples were used to support the findings.

In the category development phase, the metaphors that emerged from the children's answers were examined, and the ones that were similar were grouped under the same categories. The answers given by the children to the "why" questions were examined separately, and the answers were categorized through the analysis.

Validity And Reliability

In order to ensure the reliability of the study, a member check was carried out. The responses were independently examined and analyzed by three researchers. After that, the researchers came together to compare the codes. From among the codes that were assigned to different categories, the ones that were agreed upon by all three researchers were finally used. In order to support the validity of the research results, examples that were considered to best represent the metaphors were given in the findings section without changing the children's statements.

RESULTS

In this study, two questions were asked to reveal the children's perceptions of mathematics. The purpose of both of the following questions asked in line with the aim of the study was to reveal what the mental perceptions of children were about the concept of mathematics: (1) "What do you think mathematics is like? Why?" and (2) "If mathematics were a color, which color do you think

it would be? Why?" In this section, findings obtained in line with this purpose are presented separately for each of the two questions.

Findings on The Question "What do You Think Mathematics is Like? Why?"

Findings on this question are presented in two sections. First, the children's responses to the question "What do you think mathematics is like?" were examined, followed by their responses to the question "Why?"

Table 1. Analysis table for the question "What do you think mathematics is like?"

Categories	Metaphors	f
Lesson	Assignment, activity, lesson, line study, learning, exam, line, text	51
Concept	Triangle, square, number, addition/reduction, subtraction	31
Human	Woman, man, girl, boy	13
Color	Pink, color of pencil, skin color	13
Stationery	Book, notebook, pencil, eraser	16
Physical & Mental Occupation	Painting, activity, doing something, working, sports	17
Object	Rocket, car	9
Fear	Monster, giant	12
Unanswered		8
Total		**170**

When the metaphors about mathematics were examined, it was seen that they were frequently generated about a "lesson" or "concepts". However, interestingly, it has been seen that some children express mathematics with a metaphor of a giant oppressing people and monsters.

Table 2. Analysis table for the question "Why?"

Category	f
Discouraging Reasons	56
Neutral	51
Motivating Reasons	24
I do not know	20
Unanswered	19
Total	**170**

When analyzing the answers received from the children, it was seen that the reasons were about motivating and discouraging feelings related to mathematics. It draws attention that the discouraging reasons expressed by the children are emphasized more than motivating reasons.

"Mathematics is like an assignment because some of the assignments are also called mathematics" (C6)

"Mathematics is like a rocket. This is because it is difficult and tedious" (C34)

"Mathematics is like a monster because it is tedious" (C67)

"Mathematics is like an assignment because the teacher gets angry, sends a message asking 'Did you not do it?'" (C58)

"I liken mathematics to a lesson, or an assignment. Because, I like to do assignments" (C89)

"Mathematics is an intelligent lesson. Because, it is good and people study it." (C106)

"Math is like an enhancing sport; it is very good and people study it" (C92)

Findings on the Question "What do you think mathematics is like? Why?"

Findings on this question are presented in two sections. First, the children's responses to the question "If mathematics were a color, which color do you think it would be?" were examined, followed by their responses to the question "Why?" In this question, however, the purpose of asking the children to liken mathematics to a color was to reveal what meaning the children attributed to that color, rather than revealing what that color was. The mathematics perceptions in the minds of children were examined by means of the meanings that they attributed to the color by asking the children why they chose that color.

Table 3. Table for the question "If mathematics were a color, which color do you think it would be?"

Color	**f**
White	**24**
Red	**26**
Pink	**18**
Purple	**15**
Blue	**10**
Grey	**12**
Skin color	**13**
Green	**13**
Black	**11**
Yellow	**11**
Every color	**8**
Navy Blue	**5**
All Colors	**4**
Total	**170**

When the question "If mathematics were a color, which color do you think it would be?" was examined, the children were found to liken mathematics to 12 different colors. Four children said that mathematics was similar to every color.

Table 4. Table for the question "Why?"

Category	**Answers**	**F**
Reasons associated with teaching	Paper, learning, pencil, text, lesson	49
Emotional reasons	My favorite one	62
Personification	It wants to be like that	8
Unanswered		51
Total		**170**

It was found that four categories emerged when the reasons for the color the children likened to mathematics when responding to the question "Why?" — which was asked to reveal the children's mathematics perceptions through the meaning they attributed to the color they chose — were examined. It is seen that emotional reasons are differentiated as motivating and discouraging emotions similar to Table 2. However, in the category of "personification", it was observed that

children approach the concept of mathematics as it is a human or a living thing and used expressions that they could prefer it as such. The following are examples given by the students for the categories.

*"Whichever color is the pencil, it would be in that color, because whichever color the pencil writes, it would be a text in that color." (*Category: R*easons associated with teaching, C56)*

"It would be black, because the numbers are in black." (Category: Reasons associated with teaching, C89)

"It would be red, because it's mathematics; it is doing both addition and subtraction." (Category: Reasons associated with teaching, C77)

"It would be navy blue, because it is my favorite color." (Category: Personification, C12)

"It would be in many different colors for kids to love and learn." (Category: Emotional reasons, C12)

"It would be pink, because mathematics is pink." (Category: Personification, C4)

CONCLUSION and DISCUSSION

It was seen that the children generated 162 metaphors about mathematics. When these metaphors were examined, it was seen that the children mostly perceived mathematics as a desk study carried out using a pencil and paper such as an assignment, activity, lesson, line study, exam, and text. And also they perceive it as a monster, a giant, as an element of fear.

Bahadır and Özdemir (2012) have examined 7th grade students' metaphors about mathematics. They pointed out that students described mathematics as a calculator, sleep and a horror movie. In this context, they showed that students considered mathematics as a memorization and as a kind of calculator. In another study whose results overlap with the results of the present study, Özgün-Koca (2010) has shown that mathematics-related perceptions — "covering many subjects", "difficulty", "requiring hard work" and "usefulness for life" — come to the forefront through food-type metaphors. Yetim Karaca and Ada (2018) examined mathematics metaphors of middle school students. They stated that students thought that mathematics was only composed of numbers and procedures, and thus, they judged it through a narrow viewpoint. In addition to that, they stated that students did not know how to address mathematics in real life. In another research study that have examined gifted students' metaphors, it has been found that the students mostly describe mathematics as a lesson (Arıkan & Ünal, 2015).

When the literature regarding the current research results is evaluated; the fact that the children often mentioned a lesson, assignment, book, exam, and so on in their metaphors shows that they consider mathematics not as part of everyday life but as an activity carried out at a desk. The 2013

preschool education program of the Ministry of National Education (MNE) is a game-based program, and all the skills aimed to be given to children should be given to children through games. However, current research and other studies in the literature show that; children perceive mathematics not as a part of daily life, but only as an instructional activity.

When we look at the reasons of children's math perception; Emotional reasons were seen to be prominent in both questions posed. It is noteworthy that these feelings differ as motivating and discouraging. It is observed that discouraging emotions generally include perceptions such as fear, difficulty, and demanding effort. In addition to emotional reasons, in the question asked to attribute color to mathematics in order for children to express their perceptions more effectively and deeply; It was observed that children also said reasons based on personalization and associated with teaching differently.

Emen and Aslan (2018) examined the mathematics metaphors of 5–6-year-old children. Similar to our findings, they also created positive and negative categories as a result of their study. Özgün-Koca (2010) asked children to compare mathematics to a color when examining metaphors about mathematics. She stated that, in her study, color metaphors generated by the children were usually about emotions and attitudes. Cassel and Vincent (2011) also indicated that elementary education preservice teachers defined mathematics using metaphors like complex, challenging, confusing, and sequential. Metaphors such as ordeal, suffering and torture that emerged in a study carried out on vocational high school students show that these students were unhappy in the mathematics lesson (Güner, 2013). Moreover, studies have shown that university students think that mathematics is a difficult and boring lesson (Güveli et al., 2011), and high school students have negative judgments with regard to mathematics (Oflaz, 2011).

According to Berberoğlu (2007), the results of national and international examinations like PISA and relevant scientific research studies show that students of our country at the elementary school level are not able to succeed at a satisfactory level, especially in mathematics. Many research studies examining the relationship between achievement and attitudes have shown that there is a positive relationship between students' attitudes towards a lesson and their achievement in that lesson (Şen & Koca, 2005; Peker & Mirasyedioğlu, 2003). Koca and Şen (2005) have found that the higher the grade level of students is, the lower their positive attitudes towards the mathematics lesson are.

Children's attitudes towards mathematics are influenced by factors such as parental influences, emotional support of the teacher, and the content of education in the learning environment (Davadas & Lay, 2017). Parental effects; It includes helping their children with math difficulties, motivating children, parents' expectation of math from the child, and parents themselves attitudes

towards math (Cai, Moyer, & Wang, 1997). Teachers have a strong influence on children's perception of mathematics. Teachers' attitudes that care about children, listen to them, motivate them, respect them, care about them, treat children fairly, and have optimum expectations regarding mathematics play an important role in children's perceptions of mathematics (Sakiz, 2007). The content of the education carried out in the learning environment consists of many components: teaching strategies and materials used in the education and learning environment (Tessema, 2010); success-oriented teacher attitudes in interacting with children (Reyes & Stanic, 1988); teaching strategies such as child-centered, collaborative learning, discussion, and spatial thinking (Tessema, 2010). All these educational practices have the potential to affect children's attitudes towards mathematics in a positive or negative way. Mata et al. (2012), on the other hand, says that variables related to motivation are the main predictors in shaping children's attitudes towards mathematics. In addition, social support of teachers and peers is also very important in understanding these attitudes.

Considering the results of the present study, it is seen that children begin to develop motivating or discouraging feelings about mathematics in the preschool period. For this reason, it is necessary to provide basis for this in the preschool period in order to support the motivating feelings of children towards mathematics and to prevent them from developing discouraging feelings. In addition to this, the view that mathematics is only a desk activity consisting of notebooks, pens and numbers should be broken; Maths should be presented in a fun, necessary, and most importantly non-frightening way that takes place in the kitchen, games, songs, shopping, and many more everyday life experiences.

At the beginning of the most important educational outputs related to mathematics in preschool education; "To gain a positive attitude towards mathematics in children" is included. In this context, it can be suggested that teachers can develop strategies that support children's feelings about mathematics

It can be suggested that activities for mathematics education in preschool education institutions should be presented in a way to allow children to have fun and develop positive emotions towards mathematics, not in a way using paper and pencils at a desk.

In the present study, it was concluded that children develop negative emotions such as fear towards mathematics. In the following studies, it is suggested to investigate deeply why children develop negative emotions towards mathematics in the preschool period, although there are no negative factors such as test anxiety, failure, and low grade at a very young age.

This research was conducted directly on children. Interviews can be made with the parents of the children in order to make a more comprehensive inference about the situations in which the meaning attributed to mathematics differs. In addition to this, in-depth interviews with teachers to determine what kind of approach and how they get information about mathematics in learning environments; it can provide an in-depth view of how these metaphorical perceptions are shaped.

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