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AN INVESTIGATION OF PRESCHOOLERS' PERCEPTIONS ABOUT SCIENCE AND MATHEMATICS THROUGH METAPHORS[i]

Meltem Emen[ii],
Durmuş Aslan
University of Cukurova,
Education Faculty,
Turkey

Abstract:
Mathematics and science are important concepts that children's encounter in both daily and educational life. Early childhood is the time in which the first ideas of the mathematics and science developed. In this study, we investigated children's perceptions about mathematics and science through metaphors in terms of being able to provide rich information. This study was qualitative research in the form of phenomenological. Participants consisted of 88 children from five and six years old groups. As a data collection tool, we used a semi-structured interview form. As a result of the analysis, we found out that there were five positive and one negative category about mathematics. The category that was used most commonly about mathematics was "mathematics as a part of education". On the other hand, all of the metaphors about science were in the positive category. Metaphors about science were grouped under four categories. The category that included the highest number of metaphors was "science that involves phenomena and creatures in nature". In conclusion, children's metaphors about mathematics included elements such as "homework, line, and course", while the metaphors about science included elements such as "nature, curiosity, and research".

Keywords: preschool education, mathematics, science, metaphor

1. Introduction

For children, mathematics and science are two concepts that will exist in their educational life starting from preschool. Because it is highly probable that the thoughts and beliefs about these concepts obtained in the early childhood will maintain in the following years, children's perceptions about mathematics and science in preschool years when they have their first experiences are of great importance. This study aims to

[i] This article has been presented EJER Congress Antalya, Turkey, 2018.
[ii] Correspondence: email meltememen@cu.edu.tr

investigate five to six-year-old Turkish children's perceptions about mathematics and science through metaphors.

Preschool children, due to their natural desire for learning, are in a constant exploration process. Children count their steps, create new products with materials painted in different colors, build towers with blocks and notice that the features of these things are not the same with each other (Clements & Sarama, 2000). In addition, they might wonder where a cow's baby comes from or observe that people's eye colors are different from each other. In the preschool period, children have natural motivation for mathematics which is exploratory and experiences which have scientific content. In time, all of these experiences form first personal constructs and perceptions about mathematics and science in children's minds (Brenneman, Stevenson & Frede, 2009).

2. Perceptions about Mathematics

Today, it is commonly acknowledged in all stages of education including preschool that mathematics is not only about numbers, calculations and symbols (Courant, Robbins & Stewart, 1996). Mathematics in the preschool period is based on children's learning by doing and experiencing. Families and teachers should provide children with creative environments and appropriate educational opportunities so that they could be more successful in mathematics and develop positive attitudes towards mathematics in the future (Aktaş Arnas, 2012). Eugene (2001) reported that the child's relationship with mathematics starts with birth; each child is actually mathematician who explores, and all children need understanding parents and stimulating environments.

Children live their experiences about mathematics at home environment as well. Later experiences about mathematics go on in a planned way in kindergarten. Informal foundations of the mathematical knowledge that will be given in primary school years are laid in the preschool years. Strength of this foundation is directly related to the nature of the activities conducted by not only families but also preschool teachers (Güven, Karataş, Öztürk, Arslan & Gürsoy, 2013). Besides, teachers' perceptions and thoughts about mathematics determine the quality of the activities to be instructed to children (Hill, Shilling & Ball, 2004), and whether consciously or unconsciously, children are affected by their teachers' views, attitudes and behaviors about mathematics (Aslan, Gürgah Oğul & Taş, 2013).

3. Perceptions about Science

The word science derives from the Latin word "scientia" and means "knowledge", which is processing information (Martin, Sexton, Wagner & Gerlowich, 1997). Every event in nature is within the scope of this knowledge field, and this information is formed with the combination of some other information with different structure (Uyanık Balat, 2014). Science for preschool children means exploration and what is meant by exploration is child's "doing" something by using five senses (Armga et al., 2002). The main purpose of science education in the early childhood is to make children

guess, observe and develop positive attitudes towards science (Dawies & Howe, 2003). The purpose of science education at this period should never be the direct transmission of science concepts to children. Therefore, parents and teachers should provide children with experiences in which they can observe, measure and interpret (Tipps, 1982, cited in Aktaş Arnas, 2002). Children's first thoughts about science occur in the early years of childhood, and it is highly probable that these positive or negative thoughts exist in following years as well. Both parents and teachers should provide appropriate conditions for children to earn these structures positively (Sueck, 1991).

Most of the past studies research of perceptions of mathematics and science, focused on teachers' perceptions about these fields (Pfannkuch, 2001; Tsitouridou, 2007; Johansson, 2015; Cooke & Bruns, 2018) and determined teachers' thoughts about science and mathematics affect what type experiences they provided to children. However, this information is not sufficient to provide the child with better mathematics and science experiences. Therefore, researchers needed to understand what children think about math and science. A limited number of researchers study with primary school children, tried to put forth the perceptions of mathematics and science into various forms by conducting surveys, making interviews and drawing pictures to the children. (Hill, Shilling & Ball, 2004; Newton ve Newton, 2007; Ummanel, 2017) One of the ways in which these perceptions are revealed is metaphors. Metaphor is one of the ways for researchers to identify children's perceptions about mathematics and science. Etymologically, the word metaphor derives from the combinations of the Greek word meta and pherein (move, take), and it means "transferring, moving away" (Bourke, 2014). Metaphors enable individuals to identify the conceptual traces in their minds with some other words that are not related to that concept; is it frequently used in educational research as it provides rich data (Taylor, 1984).

The related literature includes some studies that aim to reveal children's perceptions about mathematics and science in primary and secondary school. Studies showed that commonly, children were found to mention both fields as "something beneficial", "something they learned from school or teachers", "something boring", or "something fun" (Speerin & Rennie, 1996; Neathery, 1997; Güler & Akman, 2006; Lee, 2010; Ada, 2013; Altın & Demirtaş, 2013; Zhai, Jocz & Tan, 2013). In addition, these common answers, studies in these fields showed spesific results, for example;

Related with mathematics; Nowosad (1997), collected data from the children through individual interviews and drawings, and they identified early mathematics as "calculator", "something easy", "teacher explanations". In primary school, children had typically viewed mathematics as "a set of rules" and "problem solving procedures" (Frank, 1988; Franke & Deborah, 1997). Thiery (2017), working with secondary level students, determined that children perceive mathematics as "a hard game", "formullas" and "stressfull".

Related with science; Dubosarsky (2011), found that the pre-school period that children have a fairly stereotypical mindset, and these thoughts generally appear as "volcanoes," "human bodies," and "chemicals". In another study, researchers examined the science perceptions of pre-school children, it was revealed that most of the children

in the study group couldn't answer and the others who answered expressed as "knowing", "formulas", "elixirs" (Güler & Akman, 2006). In a study with secondary school students, children's perceptions of science were examined through metaphors and it was seen that children attributed characteristics such as "field of study", "pleasure", "something important", "cumulative / progressive" (Aktamış &Sönmez, 2016).

In light of this background and when the importance of mathematics and science for children's life is considered, the fact that it was not introduced how children's perceptions is in these two fields at preschool period was made us think that this research would contribute a lot to the related literature. In this study, mathematics and science perceptions of children were aimed to examine and following questions were searched.

1. How are the perceptions of preschool children about mathematics?
2. How are the perceptions of preschool children about science?

2. Material and Methods

2.1 Participants

The participants of this study were 88 five and six-year-old children who attended three preschools in the city center of Adana, Turkey. Table 1 demonstrates demographic characteristics of children and their families.

	Groups	f	%
Age	5 years old	44	50
	6 years old	44	50
Gender	Girl	41	47
	Boy	47	53
Mother Education Levels	High School	30	34
	Associate's degree	18	20
	Undergraduate degree	30	34
	Master degree	5	6
	PhD degree	5	6
Father Education Levels	High School	29	32
	Associate's degree	19	22
	Undergraduate degree	30	34
	Master degree	5	6
	PhD degree	5	6
Mother occupation	Housewife	31	34
	Officer	28	33
	Academician	5	6
	Engineer	4	5
	Private sector	20	22
Father occupation	Officer	30	34
	Worker	13	15
	Engineer	6	7
	Academician	5	6
	Private sector	34	38

Half of the children were five years old (Range = 60-66 months, M = 63 months) while the other half were six years old (Range = 72–74 months, M = 73 months). There were 21 girls and 23 boys in the five years old group, while there were 20 girls and 24 boys in the six years old group. Of all the mothers, 30 graduated from high school, 18 had associate degree, 30 had undergraduate degree, five had master's degree, and five had PhD degree. In addition, 29 of the fathers graduated from high school, 19 had associate degree, 30 had undergraduate degree, five had master's degree, and five had PhD degree. The findings suggest that the parents graduated mainly from high school and university. As for the mothers' occupation, 31 were midwives, 28 were officer, 20 were private sector workers, 5 were academicians, and four were engineers. As to the fathers, 30 were officer, 34 were private sector workers, 13 were employees, 6 were engineers, and five were academicians. Parents' occupations included mostly civil servants, private sector workers, and housewives in comparison to other occupations.

2.2 Data Collection Tool

Data were collected by using a semi-structured interview form developed by the researchers. The form had two questions, which were "what is mathematics like in your opinion?" and "what is science like in your opinion?" After both questions, the participants were asked to explain the reason for their response. Metaphor questions generally include the completion of a statement "….is like…. because…." However, as preschool children do not know how to read and write, data were collected through interview forms, and the questions were asked to the children by the researcher.

2.3 Data Collection Process

Initially, research questions were identified because data were going to be collected through semi-structured interviews. After the required permissions were obtained from the school administration, one of the researchers enabled the participants to get accustomed to her presence by spending half day in each classroom where the study would be conducted. Data were collected by the researcher through individual interviews conducted with them. The researcher first asked warm-up questions such as "Do you know what mathematics/science is?", "What are there in mathematics/science?" etc. Then the researcher asked the children the question "What do you think mathematics/science is like?" After the child responded, the researcher then asked the child for the reason of his/her answer and recorded that answer on the interview form. The interviews took 4 to 11 minutes on the average.

2.4 Data Analysis

Steps followed in the data analysis process included classifying, eliminating, categorizing, enhancing validity and reliability, calculating frequencies, and interpreting the data. Firstly, all the forms were reviewed and those which did not include a valid metaphor were eliminated. The responses that did not have a complete metaphor, which remained as a definition, that were not answered or that were not provided with any reasons for the metaphor were excluded from the analysis. Then the

valid metaphors and the reasons for these metaphors were recorded on computer. The metaphors about science and mathematics were coded considering the previous research in literature. The metaphors that were cited commonly by the participants and the responses that were thought represented the categories were identified.

For the reliability of the study, the process was explained in a detailed way. In addition, the findings were presented with the original utterances of the participants so that the reliability and validity of the research could be enhanced. The participants' names were not mentioned in the utterances, instead codes such as "C1, C2" etc. were used. The participants' age was indicated by using "5/6" numbers and gender was indicated by "g/b" letters.

3. Results

This section presents metaphors about mathematics and science produced by children and their distribution.

3.1 Children's Metaphors about Mathematics

Of the 88 children, 54 could produce valid metaphors about mathematics, and the number of valid metaphors was 56. Only two of the children could produce more than one metaphor about mathematics (they produced two for each). The percentage of the children who could produce valid metaphors in both age groups was 64%.

There were five positive categories and one negative category about the children metaphors. Positive categories were "mathematics as part of education", "enjoyable/popular/easy mathematics", "mathematics which runs mental process skills", "mathematics which brings success", and "mathematics which is the tool in life", while negative category was "mathematics which is complicated/hard to learn".

Table 2: Metaphors about category of "mathematics as part of education"

Categories	Metaphors about mathematics	Number of metaphor types	Number of metaphors produced	Percentage of data by total number of mathematical metaphors
The mathematics as the part of education	-homework 7 -study 4 -writing 3 -lesson 2 -exam 2 -paint and write -black board -pasting work -book -work -read -line works	14	26	46.42

Children produced 26 metaphors in 14 different types about the category of "mathematics as part of education". The most produced metaphors in this category were "homework", "study" and "writing". Direct original utterances of the children's developed metaphors were as follows:

For the "*lesson*" metaphor
"Because it's about course subject, both lesson and mathematics related course" (c1-4-g)
For the "*homework*" metaphor
"Because teacher gives us the homework. We do homework on the paper and we do mathematics on the paper" (c4-6-b)
For the "*line works*" metaphor
"Because I think there are a lot of lines and drawn things in mathematics " (c8-6-g)

Table 3: Metaphors about category of "mathematics which runs mental process skills"

Categories	Metaphors about mathematics	Number of metaphor types	Number of metaphors produced	Percentage of data by total number of mathematical metaphors
Mathematics which runs mental process skills	-resolve -resolve a test -crossword -something confusing	4	4	7.14

Table 3 shows the metaphors that children make about the category of "mathematics which runs mental process skills". Children produced four different metaphors in this category. The metaphors in this category were "resolve", "resolve the test", "puzzle" and "something confusing". One of the quotes about children's metaphors was as follows:

For the "*resolve a test*" metaphor
"There are crosswords related mathematics, sometimes we solve them" (c44-5-g)

Table 4: Metaphors about category of "enjoyable/popular/easy mathematics"

Categories	Metaphors about mathematics	Number of metaphor types	Number of metaphors produced	Percentage of data by total number of mathematical metaphors
Enjoyable/popular/easy mathematics	-to play a game 2 -play -heard -work -enjoy -have fun -letters -song -cat	12	13	23.21

	-draw a picture -lesson and writing			

There were eight metaphors in seven different types about the category of "enjoyable / popular / easy mathematics". The most produced metaphor in this category was "play". Direct citations of children's metaphors were as follows:

For the "*play a game*" metaphor
"*Because math is very funny like a play*" *(c19-5-g)*
For the "*work*" metaphor
"*Because it is easy to work*" *(c11-5-b)*

Table 5: Metaphors about category of "mathematics which brings success"

Categories	Metaphors about mathematics	Number of metaphor types	Number of metaphors produced	Percentage of data by total number of mathematical metaphors
Mathematics which brings success	-homework -something finder a job -doctor -lesson -working	6	6	10.71

The metaphors of the category "mathematics which brings success" are shown in Table 5. Children produced five metaphors in five different types related to this category. Quotes about the children's metaphors were as follows:

For the "*doctor*" metaphor
"Because I will be a doctor, doctors know mathematics very well" (c3-5-b)
For the "*homework*" metaphor
"Because the topics of math and homework are related to success" (c34-6-g)

Table 6: Metaphors about category of "mathematics which is complicated/hard to learn"

Categories	Metaphors about mathematics	Number of metaphor types	Number of metaphors produced	Percentage of data by total number of mathematical metaphors
Mathematics which is complicated/hard to learn	-something confusing	1	1	1.78

There was only one metaphor (something confusing) about the category of "mathematics which is complicated / hard to learn" and this category also was only negative category in this study. Direct utterance about this category was as follows:

For the "*something complicated*" metaphor
"Math is hard to learn, it needs do measurement. Measurement is complicated" (c41-6-g)

Table 7: Metaphors about category of "mathematics which is the tool in life"

Categories	Metaphors about mathematics	Number of metaphor types	Number of metaphors produced	Percentage of data by total number of mathematical metaphors
Mathematics which is the tool in life	-head 2 -bear -Tv -world of numbers -my name	5	6	10.71

Children derived five metaphors in four different categories under the category of "mathematics which is the tool in life". The most produced metaphor in this category was "head". Direct citations of the children's metaphors in this category were as follows:

For the "*head*" metaphor
"*Because it seems like circle" (c26-5-g)*
For the "*tv*" metaphor
"*Because it's like episodes. Firstly episode 1. plays then episode 2. plays… there is math in tv'' (c17-6-b)*
For the "*my name*" metaphor
"Because it has writings" (c40-6-b)

3.2 Children's Metaphors about Science

In the current study, of the 88 children, 47 could produce a valid metaphor about science. Total number of metaphors was 52. While 44 out of 47 children could produce one metaphor each, three of them produced more than one metaphor. 22 children could produce a valid metaphor in five years old group, while 25 children could produce a valid metaphor in six years old group. There four category about science metaphors. These categories were "science as a part of education", "science that involves phenomenon and creatures in nature", "science as something popular/fun" and "science as a research tool or mystery". There was no negative category about science.

Table 8: Metaphors about category of "science as a part of education"

Categories	Metaphors about science	Number of metaphor types	Number of metaphors produced	Percentage of data by total number of science metaphors
Science as a part of education	-homework -lesson and homework -doing a homework -book -mathematics -my name -working -something with a voice	8	9	17.30

Table 8 shows metaphors about the category of "science as a part of education". Children created nine metaphors in eight different types related to this category. The most produced metaphor in this category was "homework". Excerpts related to metaphors developed by children were as follows:

For the "*lesson*" metaphor
"Because I learn things that I did not know before'' (c18-5-g)
For the "*mathematics*" metaphor
"Because my teacher gives us homework for both of them (science and math)" (c19-5-b)

Table 9: Metaphors about category of "science that involves phenomenon and creatures in nature"

Categories	Metaphors about science	Number of metaphor types	Number of metaphors produced	Percentage of data by total number of science metaphors
Science that involves phenomenon and creatures in nature	-animals 3 -creatures 2 -tree 2 -cloud -dog and bear -nature -find plants -world -a play with plants -science center shaped like a heard -explosion -jungle -water -protecting	18	22	42.30

	nature -animal pictures -air conditioner -bee

Children created 21 metaphors in 17 different types related to the category of "science that involves phenomenon and creatures in nature". The most produced metaphor in this category was "animal". Direct utterances about children's metaphors in this category were as follows:

For the "*jungle*" metaphor
"Because jungle is full of animals and science is also full of animals" (c29-5-g)
For the "*cloud*" metaphor
"Because clouds make rain and lightning flash in nature" (c8-5-g)

Table 10: Metaphors about category of "science as a research tool or mystery"

Categories	Metaphors about science	Number of metaphor types	Number of metaphors produced	Percentage of data by total number of science metaphors
Science as a research tool or mystery	-research 3 -telescope 2 -planet, moon, star -astronaut -nature observer -something we wonder -ask a question	9	12	23.07

Table 10 demonstrates metaphors about the category of "science as a research tool or mystery". Children developed 12 metaphors in nine different types related to this category. The most produced metaphor in this category was "research". Children's utterances directly related to metaphors in this category were as follows:

For the "*research*" metaphor
"Because we are digging the ground and we research plants in science" (c16-5-g)
For the "*astronaut*" metaphor
"Because we learn sciences like an astronaut" (c35-5-b)
For the "*telescope*" metaphor
"Because we can investigate the things in the space like in the science" (c39-6-b)

Table 11: Metaphors about category of "science as something popular/fun"

Categories	Metaphors about science	Number of metaphor types	Number of metaphors produced	Percentage of data by total number of science metaphors
Science as something popular/fun	-fun 3 -smell -heard -animals -mom and something we love -starfish	7	9	13

Children created 9 metaphors in 7 different types related to the category of "science as something popular/fun". The most produced metaphor in this category was "fun". Direct utterances about children's metaphors in this category were as follows:

For the "*fun*" metaphor
"Because there are wet things in science therefore I can play with mud and have fun" (c14-5-g)
For the "*animals*" metaphor
"Because I love both animals and science" (c17-6-b)

4. Discussion

This study investigated five to six-year-old children's perceptions about mathematics and science through metaphors, which is a tool that connects two objects or concepts to each other. The children produced metaphors about mathematics that were mainly in the "mathematics as part of education" category. While the metaphors in this category attributed features such as "homework, course, line works, exams" to mathematics, other categories attributed such features as "solving, having fun, being a complicated thing". Hence, the metaphors in the features such as course and homework were more in number than the metaphors such as being a fun and popular thing. Similar metaphors were found in children in older age groups. In their study conducted with primary school children, Uçar et al. (2010) found that children produced metaphors about mathematics such as "numbers and algorithm", "working", "finding the right answers", and "being a hard and boring thing". In another study with primary school children, Taylor (1984) found out that children imagined mathematics as a calculator, sleep, and horror film. Moreover, in the metaphor study conducted with preschool, primary school and secondary school children, Ummanel (2017) found that children's positive perceptions about mathematics decreased with the increase in age.

Children's metaphors such as "homework", "hard and boring" contradict with the principle that mathematics should be based on the exploratory, entertaining activities and games in the preschool period (Pyle & Bigelow, 2015; Lynch, 2015), which could be resulted from teacher-centered practices. Studies that investigated teachers'

practices about mathematics activities in preschool (Carpenter et al., 1993; Tarım & Deretarla Gül, 2003; Vilette, 2002; Wilkins et al., 2001 Baki & Hacısalihoglu Karadeniz, 2013) indicated that teachers did not use active learning methods based on new approaches adequately, implemented the curriculum with known teacher-centered methods, mostly dealt with counting, did subtracting and adding, and did not provide their students with rich experiences.

The Children's metaphors about science did not include any negative categories. The category that involved most of the metaphors was "science that involves phenomenon and creatures in nature". It was also found that children attributed features such as "nature, animals, interest, curiosity, and entertainment" to science. The reason for this is that preschool children's experiences about science are not desk-based, it happens mainly with the interaction of nature and by doing and experiencing. Speering and Renie (1996) found that children in early ages mainly defined science as "fun" and "hands on" activity. However, it was found out that this positive perception decreased in the following years. These negative perceptions might have resulted from teachers' failing to meet children's expectations and students' having difficulties in communicating with the teacher. Similarly, in their study conducted with four, five and six year-old groups, Newton and Newton (2007) found that science was typically drawn as "something about animals", "something done with new materials", and "something done by human hand". Afacan and Sosyal (2012) stated that children in primary school perceived science as "informative" and "integrating different branches".

In comparison to mathematics, the number of metaphors about science was lower in number and the "I do not know" answer was much higher, which is an important finding to note. Similarly, numerous studies in literature (Newton & Newton, 1992; Barman, Ostlund, Gatto & Halferty, 1997; Güler & Akman, 2006) asked children about their perceptions about different course fields, and it was found that they expressed lowest number of views in the field of science. This case might result from the fact that children have much limited knowledge and experience about science and/or teachers give place to mathematics activities more than they do to science activities. Numerous studies that investigated preschool teachers' attitudes towards science and self-efficacy are parallel to this fact. Teachers generally reported that they had relatively less science activities and in these science activities, they spent time mostly for experiments, and they planned mainly teacher-centered demonstration experiments (Vural & Hamurcu, 2008; Bursal & Paznokas, 2010; Yuo, Justice, Sawyer & Tompkins, 2011).

5. Conclusion

Current study found that five to six-year-old children could produce metaphors about science and mathematics. The number of children's metaphors about mathematics was more than the number of metaphors about science. There were five positive and one negative category about mathematics. The positive categories included "mathematics as part of education", "enjoyable/popular/easy mathematics", "mathematics which runs

mental process skills", "mathematics which brings success/makes life easy", and "mathematics which is the tool in life", "mathematics in terms of the resemblance of its concepts to objects" while the negative category was "mathematics which is complicated/hard to learn". The category that was used most commonly was "mathematics as part of education". On the other hand, all of the metaphors about science were in the positive category. Metaphors about science were grouped under four categories. These categories were "science as part of education", "science that involves phenomenon and creatures in nature"; "science as something popular/fun" and "science as a research tool or mystery". The category that included the highest number of metaphors was "science that involves phenomena and creatures in nature". In conclusion, children's metaphors about mathematics included elements such as "homework, line, and course" while the metaphors about science included elements such as "nature, curiosity, and research".

It is suggested that teachers should get active experiences in children by moving away from traditional methods during mathematics and science activities. Programs should be organized about how educators will include contemporary approaches in teaching mathematics and science in education. This study was limited 88 children. Research with bigger participant group and longitudinal studies are recommended to better reveal children's perceptions and the changes in these perceptions.

About the Author(s)

Meltem Emen is Research Assistant in Department of Early Childhood Education at Cukurova University. She is master student at the Cukurova University. Her publications are focused on early childhood education, early social skills and preventing child abuse.

Durmuş Aslan is Head of Early Childhood Education Department at the Cukurova University. He received PhD in Early Childhood Education Department from the Cukurova University, Adana, Turkey. His second PhD in Child Development from the Ankara University, Ankara, Turkey. He has published many scholarly articles and book parts in the area of early childhood education.

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