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Metaphorical Perceptions of Preschool, Elementary and Secondary School Children About Science and Mathematics

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ABSTRACT

The key purpose of this paper is to offer an exploration of the metaphorical perceptions of preschool, elementary and secondary school children about science and mathematics. In this study, phenomenological research design is used which is among qualitative research designs. A total of eighty-two children were participated in the study. The information is sourced through a form containing statements like "Science is like ....., because....." and "Mathematics is like ....., because....." and elementary and secondary school children were asked to fill in. After short conversations with preschool children about science and mathematics, they were asked "What does science/mathematics look like and why?" and their responses were noted by the researcher. The outcome of the study demonstrates that the children in general have positive attitudes about science and mathematics. Findings also indicate that children's positive attitudes increase for science and decrease for mathematics with increasing age.

Keywords: science, mathematics, metaphor, preschool, elementary education, secondary education

INTRODUCTION

Science is derived from the facts established by observations and experiment (Chalmers, 2013). It also covers mathematics; encompasses living beings and life, physical sciences and earth and space sciences as well (Yurt, 2014). Therefore, one cannot disregard the importance of science education in terms of comprehension of the environment and the world we live in. Especially science education which is given starting from early ages makes it easy for children to understand by creating the correct templates in their minds and help them to give the appropriate responses in different situations (Ayvaz, 1996; Worth & Grollman, 2003). On the other hand, the mathematics education the groundwork of which will be laid in early ages, makes it easy for children to understand the concepts about mathematics, direct their cognitive development and future education, developing the perspective of mathematics gained in school and out of the school and use it in their life (Baki & Hacısalihoğlu Karadeniz, 2013).

Studies conducted in the area of science and mathematics have shown that students are especially afraid of math courses and that they got easily demotivated and lost their interest because of this (Gierl & Bisanz, 1995; Trujillo & Hadfield, 1999; Ma, 2003). It is the instruction style of the teachers that determine whether or not the children would develop a positive perception of these courses (Johnstone, 1991; Aktaş Arnas, 2002). Especially during preschool years when children are curious, have strong imaginative powers, and are inquisitive and interrogative, science education should be given not just by transferring knowledge but based on encouraging

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State of the literature

- Having the knowledge of children's metaphorical perceptions is a helpful factor in mathematics education as much as it is in science education.
- It can be declared that the number of studies regard the metaphorical perceptions vary in the literature.
- These studies have involved teachers, candidate teachers, secondary and high school students, primary school students and preschool children and have covered the general topics.

Contribution of this paper to the literature

- There is limited number of studies regarding the children's metaphorical perceptions of science and mathematics in the literature and the existing studies have covered only secondary and high school students.
- Despite metaphorical studies have gained popularity in recent years, there has been no study regarding the preschool and elementary school children's metaphorical perceptions of science and mathematics.
- This study is important both in that there has been no previous study in this specific area and that it aims to compare different educational levels.

thinking and discovery and teachers should respect children's opinions about science that would develop during this process (Asoko, 2002). Therefore, the teacher has to encourage the children to research and provide the appropriate environmental conditions and setting (National Research Council, 2007). Similarly, starting from the early ages, active learning environments can be created for children in order to lay the groundwork for developing the mathematical concepts and skills they would be using in the future (Erdoğan & Baran, 2003). Such that, experiences gained in early ages would play an important role in children's future success in the fields of science and mathematics (Oktay, 2000).

Since we have different lives, we tend to have different visions in our minds and different perceptions as we create knowledge in our brain. The process of naming the new knowledge in our brain is called metaphor. (Senemoğlu, 2005). Metaphors are defined as expression of unknown things into known things (Perry & Cooper, 2001). In other words, they are used to symbolize our cognitive and intellectual comprehension system (Saban, 2008). Forceville (2002), talks about the existence of at least three main elements in any metaphor relation, which are the subject of metaphor, source of metaphor and characteristics to be attributed to the subject of the metaphor. For instance, in the sentence "Children are like the architects of the future because they are the ones to shape our future", the word "children" is the subject of the metaphor while the words "architects of future" are the source of the metaphor, and the expression "because they are the ones to shape our future" shows the characteristics that are thought to be attributed to the subject of the metaphor.

Metaphorical perception is usually created in classroom environment as part of the learning process. In addition to the past life of the individual, teachers play an important role as well in this process. Likewise, the perceptions to be formed during the courses would also influence their future experiences (Şahin, 2013). Using metaphors of science and math education can be influential in instruction of these courses (Duit, 1991; Wolodko, Willson & Johnson, 2003). Accordingly, Zambo and Zambo (2006) indicated that understand the students' feelings about a course is at least as important as determining their cognitive skills. In their study, Jakobson and Wickman (2007) researched the metaphoric perceptions of elementary school children about the science courses and found that the children had rich metaphors of science and these metaphors were influential in their learning. On the other hand, in another study (Korkmaz & Buyruk, 2016) it was seen that students have developed metaphors about the science course but they have not correlate these metaphors to their daily lives and therefore, they were not knowledgeable about the scientific meanings of scientific concepts.

Having knowledge of children's metaphorical perceptions is a helpful factor in mathematics education as much as it is in the science education. Whyte and Anthony (2012) stated that children's metaphorical perceptions are an important factor in decreasing children's anxieties about math and that these perceptions can help them get

rid of their anxieties. In another study, (Taing, Bobis, Way & Andersen, 2015) students' motivation about mathematics was tried to be measured and it was found that beliefs about mathematics provided insight about the way they develop strategies to learn math and solve problems. In studies regarding the metaphors that the students possessed, it was found that while the 5th and 6th grade students percept the math as numbers and simple operations (Solomon & Grimley, 2011); 9th and 10th grade students defined math as an undefined journey and a tool that had an interconnected structure, is hierarchical and is based on discovery (Schink, Neale, Pugalee & Cifarelli, 2008).

In recent years, there has been an increase in the literature in the number of studies on metaphorical perceptions. It is seen that these studies were conducted with teachers (Kuyucu, Şahin & Kapıcıoğlu, 2013; Pausigere & Graven, 2014; Çamlıbel Çakmak, Neslitürk & Asar, 2014; Giren, 2016), candidate teachers (Wolodko, Willson & Johnson, 2003; Güneyli & Akıntuğ, 2012; Ertürk Kara, 2014; Aydın & Sulak, 2015; Akgün, 2016; Latterell & Wilson, 2016), secondary and high school students (Bektaş, Okur & Karadağ, 2014; Akıncı Demirbaş, 2015), elementary school students (Kuyumcu & Özsarı, 2016) and preschool children (Ahi, Cingi & Kıldan, 2016) and covered general topics. On the other hand, it is seen that there are limited number of studies research about the metaphorical perceptions of the science and mathematics and these studies covered only secondary and high school students (Schink, Neale, Pugalee & Cifarelli, 2008; Cameron, 2010; Solomon & Grimley, 2011; Sezgin Memnun, 2013; Bıyıklı, Başbay & Başbay, 2014; Derman, 2014; Sezgin Memnun, 2015; Turhan Türkkan & Yeşilpınar, 2016; Uslu, Kocakülah & Gür, 2016; Yapıcı, 2015; Aktamış & Dönmez, 2016; Doğan, 2017).

Despite the increasing popularity of metaphorical studies in recent years, there has been no study investigating the preschool and elementary school children's metaphorical perceptions of science and mathematics. The general objective of this study is to analyze the metaphorical perceptions of children continuing different education levels such as preschool, elementary school and secondary school children towards science and mathematics.

In light of this general objective, the below sub-objectives were developed:

1. Which metaphors are used to describe participants' perceptions of the science concept?
2. Which metaphors are used to describe participants' perceptions of the mathematics concept?
3. Under which categories can the metaphors used by participants regarding the science concept be grouped in terms of their common attributes?
4. Under which categories can the metaphors used by participants regarding the mathematics concept be grouped in terms of their common attributes?
5. Do the metaphoric perceptions of science and mathematics differ depending on the educational level?

It is believed that our perceptions are shaped by our experiences and that our beliefs develop in line with that. This study is particularly significant since there has been no previous study in this area and the objective of it is to make a comparison among different educational levels.

METHODOLOGY

This study, which aims to research the metaphorical perceptions of children continuing different educational levels, conducted according to qualitative research approaches. Among the qualitative research designs, phenomenology was used in this research.

Study Group

The study group comprises 82 children at different educational levels currently enrolled in schools affiliated with the Ministry of Education of Northern Cyprus in the academic year of 2016-2017. Among the participants 25 of the children were enrolled in preschool education, 28 were enrolled in elementary school fourth grade, and 29 were enrolled in secondary school first grade. Study group was determined using convenience sampling, which is a non-probability sampling method.

Data Collection Tool

Participant opinions about the science and mathematics were obtained using metaphors. Participant children from the elementary and secondary school were asked to fill in a form containing the statements like "Science is like ....., because....." and "Mathematics is like ....., because.....". Face to face interviews were conducted with preschool children; because they do not know how to read and write. After short conversations with each of them about science and math activities, they were asked to answer "What does science/mathematics look like and why?" and their responses were recorded.

During the data collection process, children enrolled in primary and secondary school were given 10 minutes for generating metaphors while the preschool children were interviewed for around 15 minutes. The relationship between the subject and the source of metaphor was tried to be determined using the word "like" while the meaning attributed to the metaphor was tried to be determined using the word "because" in children's metaphors related to the science and mathematics.

Data Analysis

Data collected in the study were analyzed using content analysis methods that is among the qualitative research methods.

The analysis was carried out in three phases. In the first phase metaphors presented by each participant were entered in the computer and sorted. During the sorting process, the focus was mainly on whether or not the participant clearly mentioned the name of the metaphor and responded to the question "why". If the participant did not mention the metaphor and did not respond to the question of "why", his/her response was not included in the analysis. Responses of the participants who failed to meet these criteria were not included in the analysis.

In the second phase, the metaphors were listed and were examined in terms of their common attributes, were associated with a certain category and conceptual categories were formed. When a participant generated multiple metaphors, only the first metaphor was included in the analysis and the principal metaphor images that were commonly created were determined. When creating categories, the meaning attributed by participants to the metaphor, in other words, their response to the question of "why" was taken into account and in case of multiple responses, these as well were categorized. Categories created to define the metaphorical perception regarding the science were termed as "Doing nature related activities", "Science as a source of observation, research, experiment, science and knowledge,", "Activities aimed at understanding the human body", "Daily life skills", "Making correlations with other courses", "Game", "Attitudes towards science" and "Other"; while the categories created to define the metaphorical perception regarding the mathematics were termed as "Numbers and counting", "Attitudes towards mathematics", "Operations", "Shape", "Art", "Cognitive skills and problem solving" and "Usability and importance in daily life".

The third phase covers the tasks ensuring the validity and reliability. As part of the study, a total of 113 metaphor regarding science and 113 metaphor descriptions regarding mathematics were analyzed by the researcher and codes were examined and themes were created. With the goal of ensuring internal reliability of this analysis, the researcher consulted an associate professor who mostly carries out studies based on qualitative research approach, has expertise in the area of educational sciences and has had previous studies related to metaphors. Accordingly, the expert read the metaphor descriptions independently and evaluated the themes created by the researcher.

As a result of the reliability calculations (106/106+7) made for the science metaphors based on Miles and Huberman's formula (Reliability = Consensus / Consensus + Disagreement), reliability between data processers was found to be 93.8%. The same calculation is done for the mathematics metaphors and as a result of the reliability calculation, validity between data processers was found to be 95.5%. Because it is higher than 70%, which is the reliability value, defined by Miles and Huberman (1994), it can be said that the reliability has been attained in terms of data analysis in this study. In addition to this, the way by which the data was collected and how findings were reached was expressed clearly, in detail and in an easily comprehendible manner; direct quotations were included;

objectivity was ensured in every phase of the study and data were stored in a manner allowing other researchers to evaluate as well.

FINDINGS

This section presents the findings of the study based on the sub-objectives.

Metaphorical perceptions about the science concept

According to the findings obtained after data analysis, the participants developed a total of 48 valid metaphors regarding the science concept. 33 of these metaphors were expressed by just a single participant. The metaphors are expressed by more than one participant; course (f:7), science (f:7), technology (f:5), experiment (f:4), nice (f:4), leaf (f:3), having fun (f:3), collect the leaves (f:2), earth (f:2), water (f:2), painting (f:2), game (f:2), fun (f:2), air (f:2) and passion (f:2) metaphors respectively. **Table 1** presents the metaphors generated for science concept by the participants.

Table 1. The metaphors generated for science concept

Metaphors	f	%	Metaphors	f	%	Metaphors	f	%
Course	7	8.5	I don't know	1	1.2	Brain	1	1.2
Science	7	8.5	Looking at leaves	1	1.2	My mom	1	1.2
Technology	5	6.1	Our inside	1	1.2	Scientist	1	1.2
Experiment	4	4.9	Turkish book	1	1.2	Myself	1	1.2
Nice	4	4.9	What I love	1	1.2	Watermelon	1	1.2
Leaf	3	3.7	Outdoors	1	1.2	Requiring logic	1	1.2
Having Fun	3	3.7	Important	1	1.2	My life	1	1.2
Collecting leaves	2	2.4	Knowledge	1	1.2	Thing that eases life	1	1.2
Earth	2	2.4	Activity	1	1.2	Mysterious events	1	1.2
Water	2	2.4	Life	1	1.2	Life lesson	1	1.2
Painting	2	2.4	Sugar	1	1.2	Peach	1	1.2
Game	2	2.4	Medicine	1	1.2	Nature	1	1.2
Fun	2	2.4	Answer	1	1.2	Strawberry	1	1.2
Air	2	2.4	Glass	1	1.2	Plum	1	1.2
Passion	2	2.4	Everything	1	1.2	Learning different things	1	1.2
Paint	1	1.2	Tree	1	1.2	Mixture of oil and water	1	1.2
Total						**82**		**100**

As can be seen in **Table 1**, in addition to generating similar metaphors, the participants have developed very unique metaphors as well. It is noticed that these metaphors are mostly related to nature, human body, other courses and attitudes.

Metaphorical perceptions about the mathematics concept

Participants have generated a total of 40 metaphors related to mathematics concept. 33 of these metaphors were expressed by just a single participant. Metaphors expressed by two or more participants are numbers (f:21), course (f:8), addition, subtraction, multiplication, division (f:5), calculation (f:4), nice (f:3), solution (f:3), shape (f:2), count (f:2), brains (f:2) and shopping (f:2) respectively. **Table 2** presents the metaphors generated for mathematics concept by the participants.

As can be seen in **Table 2**, the most common metaphor developed by participants regarding the mathematics concept is the numbers (f:21) metaphor. In addition, it can be seen that they also generated metaphors related to mathematical operations, daily life experiences and attitudes.

Table 2. Metaphors generated for mathematics concept

Metaphors	f	%	Metaphors	f	%	Metaphors	f	%
Numbers	21	25.6	Questions	1	1.2	Brain box	1	1.2
Course	8	9.7	Problem	1	1.2	Cabbage	1	1.2
Addition, subtraction,			Teacher	1	1.2	Candy	1	1.2
multiplication, division	5	6.1	Earning	1	1.2	Cube	1	1.2
Calculation	4	4.9	Boring	1	1.2	Heart	1	1.2
Nice	3	3.7	Intelligence	1	1.2	Difficult	1	1.2
Solution	3	3.7	Operations	1	1.2	Passion	1	1.2
Shape	2	2.4	Colorful	1	1.2	Essence of knowledge	1	1.2
Counting	2	2.4	Ugly	1	1.2	Cherry	1	1.2
Brain	2	2.4	Important	1	1.2	Thoughtful	1	1.2
Shopping	2	2.4	Triangle	1	1.2	Pencil	1	1.2
Fun	1	1.2	Soil	1	1.2	Family	1	1.2
What I like	1	1.2	Domino	1	1.2	Running a supermarket	1	1.2
Friend	1	1.2	Number machine	1	1.2			
Total						**82**		**100**

Categories obtained from science related metaphors

Participants who generated a total of 82 metaphors of science, expressed different sentences regarding the qualities they attributed to these metaphors. The categories formed based on these descriptions are given in **Table 3.**

As can be seen in **Table 3**, the qualities that participants attributed to the metaphors they developed regarding the science concept were gathered under eight categories. It is seen that the meanings attributed to the metaphors generated are gathered mostly under *Attitudes towards science* (n=49) category, which has a share of 43.4%. Under this category, while many participants expressed positive attitudes (36.2%), some of them expressed negative attitudes (6.1%).

"*Science is like using paint, because it can be boring sometimes*" (P20).

"*Science is like education and technology, because it stays in your memory*" (P44).

"*Science is like science, because it is mixed like ice cream*" (P60).

"*Science is like mysterious events, because I like experiments and trying different things*" (P75).

The other category where a meaning is attributed most commonly is the *Science as a source of observation, research, experiment, science and knowledge* (n=28) category. The meanings attributed to the metaphors by 24.7% of the participants are in this category. It was seen that, in addition to mostly having positive attitudes towards science, the participants also correlated science with observation, research, experiments and science.

"*Science is like finding answers to our questions, because we put tinsel in our hand and observed microbes and seashells*" (P3).

"*Science is like mysterious events, because science involves researches and science-fiction*" (P46).

"*Science is like a tree, because science has many topics*" (P64).

It was also found that the participants made correlations with the other courses using the meanings they attributed to science. The courses that participants correlated with science are geography (n=4), art (n=8), mathematics (n=1) and Turkish (n=1). The sentences that resulted reaching this conclusion are as follows.

Table 3. Distribution of the categories about the qualities attributed to metaphors generated in relation to the science concept

Categories	Qualities attributed via metaphors	n	%
Doing nature related activities	We planted flowers in the garden, we watered the flowers, we gathered leaves, we looked at leaves, it tells us things about nature and our surroundings.	12	10.6
Science as a source of observation, research, experiment, science and knowledge	We analyze microbes, we water melon seeds, we looked at sea shells, we put water in the bottle, we learn new things, it is about research and science-fiction, it is understood by researching, we made paper ships and floated them, we make smoke, we do experiments, we learn most things from science, it is a source of knowledge, it is the source of university, it has many sources, it is about science.	28	24.7
Activities aimed at understanding human body	We see skeleton and muscles, we saw human body.	3	2.6
Daily life skills	It talks about beings in our lives, it eases our lives, it contains things from life.	4	3.5
Making associations with other courses	We looked at the countries on earth, we painted, the world was turning, we see colors and paints, we made a play dough house and learned about mud brick, we make orange from red and yellow, we count sheep, we watch cartoons, we read and write.	14	12.4
Game	We play games	1	0.8
Attitudes towards science	Nice, fun, exciting, sometimes boring, different, I'm not used to it, I don't like it, boosts your intelligence, remains in your memory, sweet, mixed, pleasant, educatory, I don't like that course, I like to try different things, I love it.	49	43.4
Other	Imagination, our teacher is very active	2	1.7
Total		**113**	**100**

"*Science is like the world, because we made the world turn and we looked and saw its light was on!*" (P14).

"*Science is like using paint, because with watercolor paint we see colors*" (P16).

"*Science is like a game, because we count sheeps*" (P22).

"*Science is like a Turkish book, because we read and write*" (P33)

In addition, it was seen that some participants attributed meanings to the science based on their nature trips and the model kits they analyzed (n=12) and that some of them correlated science with daily living skills (n=4).

"*Science is like traveling, because we went out and gathered leaves*" (P6).

"*Science is like the inside of our body, because it has a skeleton, internal organs and many other things*" (P31).

"*Science is like life, because it talks about the living beings in our lives*" (P52).

Finally, the meaning attributed by a single participant to science was evaluated in *Game* category and the meanings attributed by two participants to science were evaluated in the *Other* category.

"Science is like the unknown, because we play games" (P25).

"Science is like a course, because we imagine" (P1).

"Science is like water melon because our teacher is so vibrant!" (P72).

Categories obtained from mathematics related metaphors

Participants who generated a total of 82 mathematics related metaphors described the qualities they attributed to these metaphors using 113 different sentences. Based upon these expressions, the categories of *Numbers and counting, Attitudes towards mathematics, Operations, Shape, Art, Cognitive Skills and problem solving* and *Usability and importance in daily life* were formed and these categories are given in **Table 4**.

Table 4. Category distribution of qualities attributed using metaphors generated in relation to mathematics concept

Categories	Metaphor descriptions	n	%
Numbers and counting	1-2-3-4-5, numbers, we write down numbers, we count toys, we bring toys as many as that number, we match numbers, we count in doubles, there are numbers on the cube.	24	21.2
Attitudes towards mathematics	It is nice, it is so much fun, it's my favorite, it is great, it makes me feel good, I love it, it is super, our teacher is great, it is complicated, it is boring, I don't like it, I would be sad.	44	39
Operations	It tells us about the operations we can make during shopping, it helps doing additions and subtractions in your head, if we write one number wrong the result will be wrong, you can do many operations with math, we can make calculations, it tells us how to do addition, subtraction, multiplication and division.	14	12.3
Shape	It has corners, we know shapes.	2	1.8
Art	We paint numbers, we paint pictures, we paint as many as the number.	7	6.2
Cognitive skills and problem solving	It takes brain, not everyone can do it, we can't give it up even if we want to, it is the course that manages us, it contains interesting solutions, we solve questions, we solve problems.	13	11.5
Usability and importance in daily life	It is important for our lives, we use it in every area of our lives, it makes our lives easier, it can be used anytime anywhere.	9	8
Total		**113**	**100**

As can be seen in **Table 4**, the qualities that participants attributed to the metaphors they generated regarding the mathematics concept were gathered under seven categories.

It is seen that the meanings attributed to the metaphors generated were gathered mostly under *Attitudes towards mathematics* category, which has a share of 39%. Under this category, while many participants expressed positive attitudes (33.6%), some of them expressed negative attitudes (5.3%).

"Math is like a friend, because I love it so much!" (P31).

"Math is like a family, because I love it so much!" (P81).

"Math is like thoughtful because it is so complicated" (P78).

"Math is like ugly, because I do not like it at all!" (P57).

It was seen that in addition to having a positive attitude towards mathematics in general, the participants associated it mostly with numbers and counting (n=24). According to the participants, the math has a direct relation with the numbers.

"Math is numbers because we bring toys as many as that number" (P2).

"Math is calculation, because we count numbers" (P12).

"Math is numbers because it is about numbers" (P53).

"Math is a cube because the cube has number on it" (P68).

It is seen that some of the metaphors that participants generated in relation with math were described under the categories of *Operation* (n=14), *Cognitive skills and problem solving* (n=13), *Usability and importance in daily life* (n=9).

> *"Math is like a number machine because it teaches us how to add, subtract, divide and multiply numbers" (P33).*
>
> *"Math is like domino because if you write one number wrong the result will be wrong" (P63).*
>
> *"Math is like shopping, because it tells us about the operations we can do during shopping" (P79).*
>
> *"Math is like cabbage, no matter how hard we work, we would do it again and again and we would peel it off like cabbage" (P66).*
>
> *"Math is like running a supermarket, because you add and find the solution" (P50).*
>
> *"Math is like a nice course, because without math we wouldn't know anything in life" (P39).*
>
> *"Math is like solution and problem, because these are what life is about" (P54).*
>
> *"Math is like the soil, we use it in every area of our lives" (P61).*

Finally, it was seen that metaphors related to mathematics were associated with shapes and art concepts.

> *"Math is like a triangle, because it has corners" (P60).*
>
> *"Math is like 4, because we paint numbers" (P24).*

Metaphorical perceptions based on educational level

One of the sub-objectives of this study is to compare the metaphorical perceptions of science and mathematics of children at different educational levels. In this regard, metaphorical perceptions of 25 preschool children, 28 elementary 4th grade children and 29 secondary 1st grade children were compared. **Table 5** presents the distribution of the science related metaphors of children based on educational level.

82 participants generated a total of 82 metaphors related to the science concept. 25 of these were generated by preschool children, while 28 and 29 of them were generated by elementary 4th grade and secondary 1st grade children respectively. The most common metaphors among those generated by preschool children are course (n = 3), leaf (n = 3) and experiment (n = 3). The most common metaphors among those generated by elementary 4th grade children are technology (n = 5) and science (n = 5), while the most common metaphors among those generated by secondary 1st grade children are science (n = 2), air (n = 2) and passion (n = 2). These metaphors are given in bold characters in **Table 5**. In general, the most commonly mentioned metaphors are science (n=7) and course (n=7).

The only common metaphor across all educational levels is having fun (n=3). The metaphors stated by both elementary 4th grade and preschool children are experiment (n=4) and game (n=2); the metaphors stated by both elementary 4th grade and secondary 1st grade children are nice (n=4) and science (n=7). On the other hand, water (n=2) was stated by preschool and secondary school children. Similarly, there are common similarities and differences related to the metaphors generated for math concept as well. **Table 6** presents the distribution of the mathematics related metaphors of children based on educational level.

The only common metaphor generated by participants from different educational levels is numbers (n=21). Numbers metaphor was stated most commonly by the preschool children.

The most common metaphor stated by the preschool children is the numbers (n=19) metaphor. The most common metaphor stated by the elementary 4th grade children is course (n=6), while the most common metaphor stated by secondary 1st grade children is addition, subtraction, multiplication, division (n=3) metaphor. These metaphors were written in bold. The most commonly stated metaphor in general is numbers (n=21) metaphor.

Table 5. Science related metaphors created based on educational level

Metaphors	Metaphor		Participants					
			Preschool		Elementary 4th grade		Secondary 1st grade	
	f	%	f	%	f	%	f	%
Course	**7**	8.5	**3**	12	4	14	-	-
Activity	1	1.2	1	4	-	-	-	-
Answer	1	1.2	1	4	-	-	-	-
Leaf	3	3.7	**3**	12	-	-	-	-
Collecting leaves	2	2.4	2	8	-	-	-	-
Looking at leaves	1	1.2	1	4	-	-	-	-
Outdoors	1	1.2	1	4	-	-	-	-
Earth	2	2.4	2	8	-	-	-	-
Water	2	2.4	1	4	-	-	1	3.4
Paint	1	1.2	1	4	-	-	-	-
Painting	2		2	8	-	-	-	-
Learning different things	1	1.2	1	4	-	-	-	-
Experiment	4	4.9	**3**	12	1	3.5	-	-
Game	2	2.4	1	4	1	3.5	-	-
Having fun	3	3.7	1	4	1	3.5	1	3.4
I don't know	1	1.2	1	4	-	-	-	-
Fun	2	2.4	-	-	2	7	-	-
Nice	4	4.9	-	-	3	10.7	1	3.4
Our inside	1	1.2	-	-	1	3.5	-	-
Turkish book	1	1.2	-	-	1	3.5	-	-
What I love	1	1.2	-	-	1	3.5	-	-
Technology	5	6.1	-	-	**5**	18	-	-
Important	1	1.2	-	-	1	3.5	-	-
Knowledge	1	1.2	-	-	1	3.5	-	-
Science	**7**	8.5	-	-	**5**	18	**2**	6.9
Life	1	1.2	-	-	1	3.5	-	-
Sugar	1	1.2	-	-	-	-	1	3.4
Medicine	1	1.2	-	-	-	-	1	3.4
Mixture of water and oil	1	1.2	-	-	-	-	1	3.4
Air	2	2.4	-	-	-	-	**2**	6.9
Glass	1	1.2	-	-	-	-	1	3.4
Requiring logic	1	1.2	-	-	-	-	1	3.4
Tree	1	1.2	-	-	-	-	1	3.4
Brain	1	1.2	-	-	-	-	1	3.4
My mom	1	1.2	-	-	-	-	1	3.4
Scientist	1	1.2	-	-	-	-	1	3.4
Myself	1	1.2	-	-	-	-	1	3.4
Watermelon	1	1.2	-	-	-	-	1	3.4
Passion	2	2.4	-	-	-	-	**2**	6.9
My life	1	1.2	-	-	-	-	1	3.4
Thing that eases life	1	1.2	-	-	-	-	1	3.4
Mysterious events	1	1.2	-	-	-	-	1	3.4
Life lesson	1	1.2	-	-	-	-	1	3.4
Peach	1	1.2	-	-	-	-	1	3.4
Nature	1	1.2	-	-	-	-	1	3.4
Strawberry	1	1.2	-	-	-	-	1	3.4
Plum	1	1.2	-	-	-	-	1	3.4
Everything	1	1.2	-	-	-	-	1	3.4
Total	**82**	**100**	**25**	**100**	**28**	**100**	**29**	**100**

Table 6. Mathematics related metaphors generated based on educational level

Metaphors	Metaphor		Participants					
			Preschool		Elementary 4th grade		Secondary 1st grade	
	f	%	f	%	f	%	f	%
Numbers	**21**	25.6	**19**	76	1	3.5	1	3.4
Calculation	4	4.9	1	4	3	10.7	-	-
Course	8	9.7	2	8	**6**	21.4	-	-
Shape	2	2.4	1	4	1	3.5	-	-
Counting	2	2.4	2	8	-	-	-	-
Addition, subtraction, multiplication, division	5	6	-	-	2	7	**3**	10.3
Nice	3	3.6	-	-	3	10.7	-	-
Fun	1	1.2	-	-	1	3.5	-	-
What I like	1	1.2	-	-	1	3.5	-	-
Friend	1	1.2	-	-	1	3.5	-	-
Number machine	1	1.2	-	-	1	3.5	-	-
Questions	1	1.2	-	-	1	3.5	-	-
Problem	1	1.2	-	-	1	3.5	-	-
Earning	1	1.2	-	-	1	3.5	-	-
Teacher	1	1.2	-	-	1	3.5	-	-
Solution	3	3.6	-	-	1	3.5	2	6.9
Running a supermarket	1	1.2	-	-	1	3.5	-	-
Boring	1	1.2	-	-	1	3.5	-	-
Intelligence	1	1.2	-	-	1	3.5	-	-
Operation	1	1.2	-	-	-	-	1	3.4
Colorful	1	1.2	-	-	-	-	1	3.4
Ugly	1	1.2	-	-	-	-	1	3.4
Important	1	1.2	-	-	-	-	1	3.4
Triangle	1	1.2	-	-	-	-	1	3.4
Soil	1	1.2	-	-	-	-	1	3.4
Brain	2	2.4	-	-	-	-	2	6.9
Domino	1	1.2	-	-	-	-	1	3.4
Brain box	1	1.2	-	-	-	-	1	3.4
Cabbage	1	1.2	-	-	-	-	1	3.4
Candy	1	1.2	-	-	-	-	1	3.4
Cube	1	1.2	-	-	-	-	1	3.4
Heart	1	1.2	-	-	-	-	1	3.4
Difficult	1	1.2	-	-	-	-	1	3.4
Passion	1	1.2	-	-	-	-	1	3.4
Essence of knowledge	1	1.2	-	-	-	-	1	3.4
Cherry	1	1.2	-	-	-	-	1	3.4
Thoughtful	1	1.2	-	-	-	-	1	3.4
Shopping	2	2.4	-	-	-	-	2	6.9
Pencil	1	1.2	-	-	-	-	1	3.4
Family	1	1.2	-	-	-	-	1	3.4
Total	**82**	**100**	**25**	**100**	**28**	**100**	**29**	**100**

The metaphors stated by both preschool children and elementary 4th grade children are calculation (n=4), course (n=8) and shape (n=2) metaphor; the metaphors stated by both elementary 4th grade and secondary 1st grade children are addition, subtraction, division (n=5) and solution (n=3) metaphors.

Table 7. Distribution of science concept related categories across different educational levels

Categories	Meaning attributed to metaphors	Participants							
		Preschool		Elementary 4th grade		Secondary 1st grade		Total	
		n	%	n	%	n	%	n	%
Doing nature related activities	We planted flowers in the garden, watered the flowers, gathered leaves, looked at leaves, it tells us things about nature and our surroundings.	11	22.4	-	-	1	3.1	12	10.6
Science as a source of observation, research, experiment, science and knowledge	We analyze microbes, water melon seeds, sea shells, we put water in the bottle, we learn new things, it is about research and science-fiction, it is understood by researching, we made paper ships and floated them, we make smoke, we do experiments, we learn most things from science, it is a source of knowledge, it is also the source of university, it has many sources, it is about science.	6	12.2	15	46.8	7	21.8	28	24.7
Activities aimed at understanding human body	We see skeleton and muscles, we saw human body.	1	2	2	6.2	-	-	3	2.6
Daily life skills	It talks about beings in our lives, it eases our lives, it contains things from life.	-	-	1	3.1	3	9.3	4	3.5
Making associations with other courses	We looked at the countries on earth, we painted, the world was turning, we see colors and paints, we made a play dough house and learned about mud brick, we make orange from red and yellow, we count sheep, we watch cartoons, we read and write.	13	26.5	1	3.1	-	-	14	12.4
Game	We play games	1	2	-	-	-	-	1	0.8
Attitudes regarding science	Nice, fun, exciting, sometimes boring, different, I'm not used to it, I don't like it, boosts your intelligence, remains in your memory, sweet, mixed, pleasant, educatory, I don't like that course, I like to try different things, I love it.	16	32.6	13	40.6	20	62.5	49	43.3
Other	Imagination, our teacher is very active	1	2	-	-	1	3.1	2	1.7
Total	**113**	**49**	**100**	**32**	**100**	**32**	**100**	**113**	**100**

The categories formed during the analysis part of the study were developed based on the meaning attributed to science and mathematics concepts by the participants. **Table 7** and **Table 8** presents the distribution of categories created for the science and mathematics concepts across different educational levels.

Based on study findings, the meaning attributed to science concept by the participants is seen most densely in the *Attitudes towards science* category. Positive attitudes related to science were stated most commonly by secondary 1st grade students (n=16). Secondary 1st grades are followed by preschool children (n=15) and elementary 4th grade children (n=11). The students who made the highest number of associations between science and other courses are the preschool children (%26.5); and in the category of *Doing nature related activities* preschool children are the group that made the highest number of statements (%22.4). While the meaning attributed by

Table 8. Distribution of mathematics concept related categories across different educational levels

		Participants							
Categories	**Meaning attributed to metaphors**	**Preschool**		**Elementary 4th grade**		**Secondary 1st grade**		**Total**	
		n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Numbers and counting	1-2-3-4-5, numbers, we write down numbers, we count toys, we bring toys as many as that number, we match numbers, we count in doubles, there are numbers on the cube.	21	42.8	1	3.1	2	6.2	24	21.2
Attitudes towards mathematics	It is nice, it is so much fun, it's my favorite, it is great, makes me feel good, I love it, it is super, our teacher is great, it is complicated, it is boring, I don't like it, I'd be sad.	19	38.7	13	40.6	12	37.5	44	38.9
Operations	It tells us about the operations we can make during shopping, it helps doing additions and subtractions in your head, if we write one number wrong the result will be wrong, you can do many operations with math, we can make calculations, it tells us how to do addition, subtraction, multiplication and division.	1	2	9	28.1	4	12.5	14	12.4
Shape	It has corners, we know shapes.	1	2	-	-	1	3.1	2	1.7
Art	We paint numbers, we paint pictures, we paint as many as the number	7	14.3	-	-	-	-	7	6.2
Cognitive skills and problem solving	It takes brain, not everyone can do it, we can't give it up even if we want to, it's the course that manages us, it contains interesting solutions, we solve questions, we solve problems.	-	-	7	21.8	6	18.7	13	11.5
Usability and importance in daily life	Important for our lives, we use it in every area of our lives, it makes our lives easier, can be used anytime anywhere.	-	-	2	6.2	7	21.8	9	7.9
Total	**113**	**49**	**100**	**32**	**100**	**32**	**100**	**113**	**100**

elementary 4th grade students to science concept was seen most is densely in *Science is a source of observation, research, experiment, science and knowledge* category (%46.8), it was seen that secondary 1st grade children attributed less meaning to science concept compared to this category (%21.8).

The meaning attributed to mathematics concept by the participants is seen most densely in the *Attitudes towards mathematics* category. Among the students that stated their attitudes towards mathematics, the ones that had the most positive attitude were preschool children (n=17), elementary 4th grade children (n=12) and secondary 1st grade children (n=9) respectively. On the other hand, negative attitudes are seen most commonly in secondary 1st grade (n=3) students.

While it was the preschool children (%42.8) that made the highest number of statements in the *Numbers and counting* category, it was seen that this rate decreased among elementary children (3.1%) and increased among secondary school children (6.2%). It is seen that the number of statements in the *Operation* and *Cognitive skills and problem solving* categories is highest among elementary school children and that the number of statements in the *Usability and importance in daily life* category is highest among secondary school children.

While making correlations between mathematics concept and art is seen only among preschool children, it was found that the meanings attributed to the *Shape* category was attributed by preschool and secondary school children.

CONCLUSION AND DISCUSSION

Findings of the study demonstrated the metaphorical perceptions related to the science and mathematics of children continuing different educational levels.

According to the study findings, participants generated a total of 48 valid metaphors related to the science concept and 33 of these metaphors were stated by a single participant. The most commonly stated metaphors related to the science concept are course and science metaphors. Other than these metaphors, the most commonly stated metaphors are technology and science metaphors, which are directly related to the science course. While course and experiment metaphors are the top metaphors stated by preschool children, the most common metaphors stated by elementary 4th grade children are technology and science. In addition, science metaphor is also among the most common metaphors generated by secondary 1st grade children.

Preschool education is a process based on education with activities and games (Pyle & Bigelow, 2015; Lynch, 2015). Just like with other activities, science education is given to the child is also through games and experiences (Tuğrul, 2014); and the terms "activity" or "game" is used instead of the term "course". (MEB, 2013). The fact that preschool children perceived science as a course led the researchers to think about the presence of a teacher who adopted an elementary school education approach to teaching and uses elementary school teaching methods. The fact that the "experiment" metaphor was stated most commonly by preschool children led to think that, due to the current curriculum, hands-on training is more common in preschool education and the fact that technology and science metaphors were the ones most commonly stated among elementary school children led to think that children get more involved with technological tools at this age. On the other hand, the science concept is a more abstract concept compared to other ones; therefore, it is natural for this concept to be uttered more frequently by children that are in more advanced stage of development. Similarly, in a study done with secondary school children, it was observed that the most commonly stated metaphors related to science course were science, experiment and life (Aktamış & Dönmez, 2016).

Considering the meanings attributed to the science concept, it was seen that the participants had more positive attitude towards science; that secondary school students used more positive expressions regarding science and they were followed by preschool and elementary school children. Even though the teacher factor plays an important role in shaping students' attitude towards the courses, (Johnstone, 1991; Laçin Şimşek & Tezcan, 2008), another similar study found that students mostly had positive attitude towards a science related course (Yapıcı, 2015).

The student group that made the highest number of correlations between the science and other courses is preschool children. In addition, it was again preschool children group that made the highest number of statements in the category of "do the nature related activities". Especially activities like painting, counting, matching, and traveling-observing, are common activities in preschool period. Therefore, it is believed that the children were led by these experiences when generating science related metaphors. Accordingly, in their study, Jakobson and Wickman (2007) found that the children generated their science related metaphors were mostly based on the most common topics covered during lessons.

In addition, the number of students who correlated the concept of science with being the source of observation, experiments, science and knowledge, cannot be underestimated. Elementary and secondary school

children made more statements that fall under this category compared to preschool children. The reason for this may be that the elementary and secondary school curriculum covers such activities extensively and aim to establish a scientific mindset in children via science activities in the long term (MEB, 2017). In addition, the idea that science is in every part of life also starts to get shaped in the minds of children during the secondary school years (Aktamış & Dönmez, 2016). Finally, the fact that only one participant associated science with "game", led to think that practical aspect of the science course is emphasized less than the theoretical aspect or that it was not found to be as fun as an activity. Accordingly, only one person from each educational level used the "having fun" metaphor is for the science concept.

The participants generated a total of 82 valid metaphors related to the mathematics concept and these metaphors are mostly under the "numbers and counting" category. These metaphors were generated mostly by preschool children. Because the activities related to numbers, matching numbers and counting are done in preschool classes, it should be seen as natural that children give responses based on such a life experience.

Another finding is that participants in the preschool level had positive attitude towards mathematics but that positive attitudes decreased in elementary and secondary school levels. The decrease in positive attitude towards mathematics can be associated with the fact that this course gets more complicated over time and that complex mathematical problems are more challenging for children. Accordingly, the metaphors of "boring", "ugly", and "difficult" stated by elementary and secondary school children in relation to mathematics can be shown as an example.

It is believed that the metaphors generated in the "Operations and Cognitive Skills" and "Problem Solving" categories were related to the current educational level of participants. Accordingly, the number of metaphors in these categories generated at elementary school level is higher than that generated at the preschool level. On the other hand, it is known that mathematics related activities get more complicated in elementary school education, and that the four operations, which are the basics of mathematics, are taught during this period and many activities aimed at problem solving were done during this period as well (Ersoy, 2006; MEB, 2017). The view that the mathematics is used in daily life and is important for daily life, is more prevalent among secondary school children. The reason for this might be that the children in this age group had basic mathematical skills and reached the cognitive level that allowed them to make correlations with daily life.

During preschool period, children would have a natural interest in learning and this attitude may vary due to certain environmental factors. Accordingly, teachers are recommended to keep the interest and motivation of the children alive in every stage of education and to stick to the principles of active learning when organizing training and educational activities.

This study can be seen as a guide in terms of comparison of perceptions of the students at different educational levels about science and mathematics. It is believed that doing such activities more often especially for preschool and elementary school children would guide us in understanding children better.

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