Mathematics Teacher Candidates' Metaphors about the Concept of "Mathematics"

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Abstract

The main purpose of this study was to research mathematics teacher candidates' perceptions about the concept of "mathematics" through the use of metaphors. The research is conducted during 2012-2013 academic year, on a group of 111 mathematics teacher candidates at the Education Faculty of a University in Turkey. To collect the research data, each participant was asked to complete the prompt "*Mathematics is like . . . because . . .*" The content analysis technique was used in this study in order to evaluate the data collected. As a result of the data analysis, it was found that 67 valid metaphors were developed by the participants. These metaphors were grouped under 14 categories. According to these categories, about 77% of mathematics teacher candidates perceived mathematics as "Limitless", "Interconnected", "Basically needed", "Fun", "Cumulative", "Indispensable" figure and as a figure which laid the "foundation for other sciences". The remaining 23% perceived mathematics as "Hard-to-understand", "Guiding", "Universal language", "Requiring continuity", "Yet to be solved", "Mind developing" and "Having single correct answer."

Key words: Metaphor, Mathematics, Teacher candidates, Attitude.

Introduction

Traditionally, a metaphor is defined as a poetical image and a rhetorical tool which is limited to use in literature. Metaphor was defined as an embellishment or a style of speaking in the past (Lakoff & Johnson, 2003). Metaphor is not a mere embellishment, it is the basic means by which abstract thought is made possible (Lakoff & Nunez, 2000). Metaphor is considered as the strongest device for an individual to comprehend and explain a hypothetical or an abstract, complex fact in a high level (Saban, Koçbeker & Saban, 2006). A metaphor is actually a way of understanding one reality by means of another reality (Romanyshyn, 2001). Metaphors are usually used for the purpose of correlating something unknown or barely known with something better known (Kovecses, 2010). Additionally, metaphors give opportunities for comparing two things, drawing attention to the similarities between two things and explaining one thing in terms of another (Saban, 2004).

Metaphors have many advantages for educators and learners. If our conceptual system and thought processes are largely metaphorical, analyzing metaphorical thinking of people is a good way to understand what happens in their mind (Lakoff & Johnson, 2003). In recent years, there were many studies conducted to investigate the metaphors about "teaching", "learning" and "teacher" concepts (Alger, 2009; Carlson, 2001; Guerrero & Villamil, 2002; Güler, Öçal & Akgün, 2011; Leavy, McSorley & Bote, 2007; Saban, 2004; Saban, Koçbeker & Saban, 2006; Saban, 2009; Yob, 2003).

According to Ernest (2010), mathematics is a complex system. Mathematics truly has many components. Indeed, as is acknowledged, the very term "mathematics" is highly indefinite. Mathematics is an organized body of knowledge, a practice engaged in by mathematicians, a school subject, a cultural object of many meanings, and a language and box of conceptual tools used variously in many different practices. Its name alone (mathematics) is ambiguous because it is a plural word that is treated as naming a single entity. Mathematics is a mysterious subject, and a number of myths are associated with mathematics. These myths include commonly expressed views including: "mathematics is only for clever people and male"; "your father is a mathematics

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teacher so you must be good in mathematics too" (Lim & Ernest, 1998). In the some researches, it was concluded that mathematics was about number and computation, a boring, difficult and dislike course (Kılıç, 2011; Picker & Berry, 2000; Raymond, 1997; Rock & Shaw, 2000; Schinck et al, 2008; Uçar et al, 2010). Furthermore most of these views about mathematics are negative. Such negative views are common and seem to be present in many countries (Lim and Ernest, 1998).

Students have various beliefs about mathematics. These beliefs are linked to interpretations of the role mathematics plays in their lives, both within and outside of school. But determining student beliefs is a difficult undertaking. Metaphor provides a means of unpacking the beliefs that students have about mathematics (Schinck et al, 2008). When literature is analyzed in terms of metaphor, there are some studies had been conducted on metaphorical images of specific content like mathematics (Kılıç, 2011; Lim & Ernest, 1998; Lim, 1999; Noyes, 2006; Reeder, Utley & Cassel, 2009; Schinck et al, 2008; Sterenberg, 2008).

Saban (2004) argued that individuals who come to faculties of education to become teachers bring many attitudes towards many concepts with themselves like teaching and learning depending on their experiences during their primary and secondary education. These perceptions of teacher candidates present deep clues about their future teaching lives. At the same time, the perceptions of teacher candidates about the concepts that they are liable to teach show how those concepts will be transferred (Öztürk, 2007). From this perspective, it is important to reveal and discuss mathematics teacher candidates' concept of "mathematics". Therefore, this study was conducted to reveal perceptions of mathematics teacher candidates with regard to the concept of "mathematics".

The aim of this study is to examine mathematics teacher candidates' perceptions with regard to mathematics through metaphor analysis. With this aim in mind, answers for the following questions were sought:

1. What kind of metaphors do mathematics teacher candidates use to explain the concept of mathematics?
2. In what category do mathematics teacher candidates collect the metaphors they use to explain the concept of mathematics?

Methods

To determine and classify mathematics teacher candidates' metaphors with regard to "mathematics" was used phenomenographic qualitative research method as described by Marton (1981). The aim in phenomenography is to describe variations of conception that people have of a particular phenomenon.

Participants

A total of 111 mathematics teacher candidates at the Education Faculty of a University in Turkey took part in this study. The participants volunteered to take part in the study. 76 (68%) of the participants were female and 35 (32%) were male and their ages ranged between 18 and 22 (mean 20.2). This study was carried out in the fall semester of 2012-2013 academic years.

Data Collection

To determine mathematics teacher candidates' metaphors with regard to "mathematics", cards on which has the sentence *"Mathematics is like………………because ......"* is written were handed out to the participants and they were asked to complete this statement using only one metaphor and explaining the reason of their metaphor. At the beginning of the study, the participants were explained what the concepts of "metaphor" meant and why it was used with examples and they were given 20-30 minutes to write an appropriate metaphor and the reason why they chose that particular metaphor. The time allocated for the students to write the metaphor was considered to be enough as the aim of this study was to make mathematics teacher candidates focus on the very first metaphor that occurred to their mind. The answers students provided for the sentence written on the cards-which is mentioned above- formed the basic source of data for our study.

Data Analysis

To determine and classify mathematics teacher candidates' metaphors with regard to "mathematics" was used phenomenographic qualitative research method as described by Marton (1981). Phenomenography systematically explores participants' experiences and identifies their conceptual meanings of the phenomenon of interest. These are classified into categories according to their similarities and differences. Finally, phenomenographic findings describe the different categories of conceptions of the phenomenon from the perspective of participants (Marton & Pong, 2005).

When analyzing the metaphors mathematics teacher candidates developed, first appropriate and in appropriate metaphors were determined. A total of 10 metaphor card in which more than one metaphors were determined or metaphors without relation between the target and source were determined, were left out of assessment. A list of metaphor was formed by coding the remaining metaphors. Second, the sources of the metaphors mathematics teacher candidates developed with regard to mathematics were read carefully and they were categorized. When categories were formed, the common characteristics of teacher candidates with regard to the concepts of "mathematics" were taken into consideration.

Reliability and Validity

Yıldırım and Şimşek (2005) state that detailed reporting of how data and results were obtained is a very important criterion for validity in qualitative research. In line with this, data collection process and analysis process were explained in detail. To ensure reliability of the study, data obtained was analyzed first by the researcher and then a professor who is an expert in this field of study and metaphors and categories were determined. The analyses carried out by the researchers and expert professor were compared and the number of metaphors and categories that overlapped and did not overlap were determined. The formula (Reliability= the number of overlapping items (metaphors) / (the number of overlapping + not overlapping ones)) developed by Miles and Huberman (1994) was used and reliability level was found to be %92. According to Miles and Huberman, values higher than 90% and over obtained using this formula are regarded to be adequate for reliability.

Results and Findings

In this section of the study, results with regard to metaphors by mathematics teacher candidates about the concept of "mathematics" are presented in tables and they were analyzed and interpreted under subheadings determined based on research questions.

1. With what kind of metaphors do mathematics teacher candidates explain the concept of mathematics?

As a result of the study, 67 metaphors in total were found to be related to the concept of "mathematics". 49 of these metaphors were provided by only one teacher candidate and the remaining 18 were provided by a number of teacher candidates ranging from 2 to 9. Top 5 metaphors were found to be: water (9 teacher candidates, 8.1%), puzzle (7 teacher candidates, 6.3%), ocean (5 teacher candidates, 4.5%), sea (4 teacher candidates, 3.6%), and riddle (4 teacher candidates, 3.6%). Among 9 metaphors that were linked with living beings, 3 were human, another 3 were plant, 2 were animal and one was a virus. 46 were tangible, and 12 were intangible objects among the 58 metaphors that were linked with non-living beings.
In Table 1, a list of metaphors developed by mathematics teacher candidates and the number and percentage of teacher candidates representing each metaphor are given.

Table 1. Metaphors developed regarding the concept of "Mathematics" and the number and percentage of teacher candidates representing them.

No.	Metaphor name	Frequency (f)	Percentage (%)	No.	Metaphor name	Frequency (f)	Percentage (%)
1	Water	9	8.1	35	Queen	1	0.9
2	Crossword	7	6.3	36	Tower	1	0.9
3	Ocean	5	4.5	37	Well	1	0.9
4	Sea	4	3.6	38	Love	1	0.9
5	Puzzle	4	3.6	39	Matryoshka doll	1	0.9
6	Tree	3	2.7	40	Letter	1	0.9
7	Space	3	2.7	41	Marsh	1	0.9
8	Language	3	2.7	42	Building foundation	1	0.9
9	Building	3	2.7	43	Aids	1	0.9
10	Game	3	2.7	44	Garden	1	0.9
11	Lantern	3	2.7	45	Money	1	0.9
12	Life	3	2.7	46	Pizza	1	0.9
13	Maze	2	1.8	47	Compass	1	0.9
14	River	2	1.8	48	Thorny rose	1	0.9
15	Oxygen	2	1.8	49	Milk way	1	0.9
16	Infinity	2	1.8	50	Ivy	1	0.9
17	Dominos	2	1.8	51	Darling	1	0.9
18	Cat	2	1.8	52	Black	1	0.9
19	Instrument	1	0.9	53	Chocolate wafers	1	0.9
20	Universe	1	0.9	54	Mind game	1	0.9
21	Clothes	1	0.9	55	Salt water	1	0.9
22	Sky	1	0.9	56	Cliff	1	0.9
23	Soccer game	1	0.9	57	Great plane	1	0.9
24	Illness	1	0.9	58	Omani	1	0.9
25	Lion	1	0.9	59	Gap	1	0.9
26	Light	1	0.9	60	Virus	1	0.9
27	Drug	1	0.9	61	Vitamins	1	0.9
28	Desk	1	0.9	62	Jigsaw	1	0.9
29	Human	1	0.9	63	Vita	1	0.9
30	Istanbul	1	0.9	64	Life source	1	0.9
31	Destiny	1	0.9	65	Star cluster	1	0.9
32	Dark caves	1	0.9	66	Brain teaser	1	0.9
33	Habit	1	0.9	67	Chain ring	1	0.9
34	Deadlock	1	0.9		Total	111	100

2. In what category do mathematics teacher candidates collect the metaphors they use to explain the concept of mathematics?

However, 60 of the 67 metaphors were under a single category while 7 metaphors were under 2 or 3 categories. For instance, the "ocean" metaphor developed by teacher candidate 54 was under *mathematics as a limitless figure* category, while the "ocean" metaphor developed by teacher candidate 28 took place under the *mathematics as a foundation figure for other fields of science.* Classification of metaphors that were developed by teacher candidates according to their categories and the number of teachers representing them are given in Table 2.

Table 2. Classification of metaphors developed by teacher candidates according to categories and the number and percentage of teacher candidates representing them.

	Categories	Number of metaphors	Number of teacher candidates	Percentage of teacher candidates
1	Mathematics as a limitless figure	14	22	19.8
2	Mathematics as an interconnected figure	11	15	13.5
3	Mathematics as a basic need figure	5	14	12.6
4	Mathematics as a fun figure	6	10	9.0
5	Mathematics as a cumulative figure	7	8	7.2
6	Mathematics as an indispensable figure	8	8	7.2
7	Mathematics as a foundation for other sciences	7	8	7.2
8	Mathematics as a hard-to understand figure.	5	5	4.5
9	Mathematics as a guiding figure.	3	5	4.5
10	Mathematics as a universal language.	2	4	3.6
11	Mathematics as a figure that requires continuity.	3	4	3.6
12	Mathematics as a figure that is yet to be solved.	2	3	2.7
13	Mathematics as a mind-developing figure.	3	3	2.7
14	Mathematics as a figure with a single correct answer.	1	2	1.8

Category 1: Mathematics as a limitless figure

In total, there are 14 metaphors represented by 22 (19.8%) teacher candidates under this category. These metaphors are "ocean" (3), "sea" (4), "space" (3), "infinity" (2), "sky" (1), "vita" (1), "omani" (1), "well" (1), "great plane" (1), "gap" (1), "black" (1), "universe" (1), "starcluster" (1), "cliff" (1). When the metaphors were analyzed, it was found that prospective teachers who developed these metaphors perceive mathematics as limitless. These teacher candidates emphasized that subjects of mathematics are infinite and that there are more to discover as new discoveries in mathematics are made. Quotes from teacher candidates' who came up with the category *mathematics as a limitless figure* are as follows:

"Mathematics is like the starclusters in space because it as limitless as they are. Just like stars, there will be further discoveries as we discover stars and you work on finding another while you have discovered one" (C23, male).

"Mathematics is like the color black, because, to me, black represents infinity and never endlessness. So does mathematics; it is infinite" (C101, female).

"Mathematics is like infinity. Just like it, it has no limit. It makes you think that, once you have achieved something, you find yourself at the very beginning and so it never ends with mathematics" (C4, female).

"Mathematics is like space because it contains many galaxies, stars, planets and many objects that we are yet to discover and learn. You can never say, okay, that is it, it is over, always new subjects come up; they are infinite" (C20, female).

"Mathematics is like the ocean in a way that when the ocean is observed from land, it seems infinite and so it is how mathematics seems when studying a subject; problems, and theorems related to that subject are so broad in scope that we are able to produce hundreds of problems within merely one problem" (C58, female).

Category 2: Mathematics as an interconnected figure

In total, there are 11 metaphors represented by 15 (13.5%) teacher candidates under this category. These metaphors are "puzzle" (4), "tree" (2), "milk way" (1), "destiny" (1), "game" (1), "matryoshka doll" (1), "chain ring" (1), "building" (1), "life" (1), "crossword" (1), "dominos" (1). When the metaphors were analyzed, it was found that the teacher candidates who came up with these metaphors perceived mathematics as an interconnected and interrelating figure. These teacher candidates pointed out that the content of mathematics are

interrelated and that one could not be formed without the other and that through searching for these correlations it is possible to achieve results. Quotes from teacher candidates' who came up with the category *mathematics as an interconnected figure* are as follows:

"Mathematics is like the Milky Way. When we consider that all planets in the Milky Way are connected to one another we can see that mathematics is interrelated within itself as a whole. In the Milky Way, elimination of a planet may destroy everything, similarly in mathematics; a vanishing expression may destroy everything" (C7, male).

"Mathematics is like a tree in a way that the roots, trunk, branches and leaves of a tree are all interconnected. In mathematics, the roots of a tree are definitions. The trunk contains demonstrations. Just like branching in a tree the theorems are interconnected and finally the leaves show the results" (C75, female).

"Mathematics is like a puzzle. When one of the pieces of the puzzle is missing, the puzzle picture cannot be completed and similarly, in mathematics, when a piece of information is missing, it is not possible to achieve results." (C99, female).

"Mathematic is like life. Every year, every month and every day of life is connected to each other. A person cannot run without first learning to walk, one cannot perform an operation without learning about numbers first and if one does not know how to perform an operation then one cannot solve a problem" (C17, female).

Category 3: Mathematics as a basic need figure

In total, there are 5 metaphors represented by 14 (12.6%) teacher candidates under this category. These metaphors are "water" (9), "oxygen" (2), "life source" (1), "money" (1), "clothes" (1). When the metaphors were analyzed, it was found that teacher candidates who came up with these metaphors perceived mathematics as a basic need to continue living. These teacher candidates pointed out that life cannot be sustained without mathematics just like one cannot survive without air and water. Quotes from teacher candidates' who came up with the category *mathematics as a basic need figure* are as follows:

"Mathematics is like water. Life cannot exist without water and so without mathematics. This is because nature is based on a certain balance and people need mathematics in order to understand this balance." (C26, female).

"Mathematics is like money because money always exists in our lives and it is indispensable. When we consider that mathematics is a science which exists for fulfilling human needs and that human needs will always exist and we cannot live without money, we cannot live without mathematics" (C32, female).

"Mathematics is like a source of life because we face it at every moment of our lives. Mathematics is involved with every discovery that carries utmost significance for people." (C59, female).

Category 4: Mathematics as a fun figure

In total, there are 6 metaphors represented by 10 (9%) teacher candidates under this category. These metaphors are "crossword" (4), "game" (2), "mind game" (1), "pizza" (1), "İstanbul" (1), "soccer game" (1). When the metaphors were analyzed, it was found that teacher candidates who came up with these metaphors perceived mathematics as a fun figure. These teacher candidates pointed out that it fun to engage in mathematics and that they it gives them joy. Quotes from teacher candidates' who came up with the category *mathematics as a fun figure* are as follows:

"Mathematics is like a game because engaging in mathematics and learning new things is pleasurable just like playing a game" (C38, male).

"Mathematics is like a soccer game. When people enjoy it while playing with a ball on the field, it is just as much fun to deal with theorems and numbers in mathematics." (C11, male).

"Mathematics is like crossword. Trying to solve mathematical problems gives me just as much pleasure to solve crossword." (C90, female).

"Mathematics is like Istanbul. It is a great pleasure once you have understood it; just like wandering Istiklal Street. Once you have solved a problem you view life from above, just like going on top of the Fortress of Rumeli and watch the view of Bosporus. Sometimes one cannot figure out a theorem and get stuck with it, just like getting stuck in traffic at the E5 highway. Regardless, one becomes happy with mathematics just like one feels in Istanbul." (C72, male).

Category 5: Mathematics as a cumulative figure

In total, there are 7 metaphors represented by 8 (7.2%) teacher candidates under this category. These metaphors are "building" (2), "dominos" (1), "jigsaw" (1), "tower" (1), "ocean" (1), "desk" (1), "dark caves" (1). When the metaphors were analyzed, it was found that teacher candidates who came up with these metaphors perceived mathematics as a cumulative figure. These teacher candidates pointed out that mathematics constitutes an accumulation of heaps of information. Quotes from teacher candidates' who came up with the category *mathematics as a cumulative figure* are as follows:

"Mathematics is like the ocean. The ocean consists of tiny water drops and so mathematics consists of an accumulation of information clusters as a body." (C15, male).

"Mathematics is like a desk at primary school. Somebody writes down on this desk and in the following years every person who sits there makes other additions. Mathematics is just like that." (C21, male).

"Mathematics is like a building. A building is constructed by placing bricks on top of each other and so is mathematics, a science formed by stacking heaps of information." (C69, female).

Category 6: Mathematics as an indispensable figure.

In total, there are 8 metaphors represented by 8 (7.2%) teacher candidates under this category. These metaphors are "virus" (1), "ivy" (1), "life" (1), "salt water" (1), "marsh" (1), "Chocolate wafers" (1), "habit" (1), "illness" (1). When the metaphors were analyzed, it was found that teacher candidates who came up with these metaphors perceived mathematics as an addictive and indispensable figure. These teacher candidates emphasized that they were not able to break off of mathematics once they have studied it and that they would like to continue dealing with it. Quotes from teacher candidates' who came up with the category *mathematics as an indispensable figure* are as follows:

"Mathematics is like a virus. Mathematics is like how an addictive virus without a working cure does not leave the body." (C12, female).

"Mathematics is like a marsh. Once you have entered a marsh, you cannot get out and once you have engaged in mathematics, you cannot leave it." (C110, male).

"Mathematics is like ivy. Once you have made contact it creeps up on you and neither can you break off of it nor can it break off of you." (C34, female).

Category 7: Mathematics as a foundation for other sciences

In total, there are 7 metaphors represented by 8 (7.2%) teacher candidates under this category. These metaphors are "river" (2), "tree" (1), "building foundation" (1), "ocean" (1), "lion" (1), "queen" (1), "garden" (1).
When the metaphors were analyzed, it was seen that teacher candidates who came up with these metaphors perceived mathematics as the foundation for other fields of science. These teacher candidates pointed out those other fields of science were nurtured by mathematics and that further advances in those fields could only be made through mathematics. Quotes from teacher candidates' who came up with the category *mathematics as a foundation for other science* are as follows:

"Mathematics is like a queen. It is the outset for all fields of science. We cannot consider any science without mathematics." (C98, female).

"Mathematics is like a lion. Just as the lion is the king of the forest, mathematics is the dominator of other fields of science." (C40, female).

"Mathematics is like the foundation of a building. If we consider other fields of science as buildings, mathematics would be their foundation. Other fields of science are able to stand by means of it." (C67, male).

Category 8: Mathematics as a hard-to-understand figure

In total, there are 5 metaphors represented by 5 (4.5%) teacher candidates under this category. These metaphors are "darling" (1), "thorny rose" (1), "deadlock" (1), "human" (1), "life" (1). When the metaphors were analyzed, it was found that teacher candidates who came up with these metaphors perceived mathematics as a hard-to-understand figure. These teacher candidates pointed out that, to them, mathematics were complicated and hard to understand. Quotes from teacher candidates' who came up with the category *mathematics as a hard-to-understand figure* are as follows:

"Mathematics is like a thorny rose. It is difficult to handle a thorny rose just as understanding mathematics." (C5, male).

"Mathematics is like a darling. It has always been difficult for me to figure out both." (C27, male).

"Mathematics is like a deadlock. It is either difficult or impossible to untie a Gordian knot, just as it is with mathematics." (C13, female).

Category 9: Mathematics as a guiding figure

In total, there are 3 metaphors represented by 5 (4.5%) teacher candidates under this category. These metaphors are "lantern" (3), "compass" (1), "light" (1). When the metaphors were analyzed, it was found that teacher candidates who came up with these metaphors perceived mathematics as a guiding figure. These teacher candidates see mathematics as a guiding tool that would help understand nature and ease life. Quotes from teacher candidates' who came up with the category *mathematics as a guiding figure* are as follows:

"Mathematics is like light. Light leads others in its environment. Mathematics, similarly to light, guides us to understand nature and helps us make advances in technology." (C53, female).

"Mathematics is like a compass. The route that mathematics leads us is the reference point for us to figure out the whole universe." (C73, male).

"Mathematics is like a lantern. It is a tool that sometimes a physicist, a chemist or an engineer uses to find his/her way." (C41, male).

Category 10: Mathematics as a universal language

In total, there are 2 metaphors represented by 4 (3.6%) teacher candidates under this category. These metaphors are "language" (3), "letter" (1). When the metaphors were analyzed, it was found that teacher candidates who came up with these metaphors perceived mathematics as a language. These teacher candidates stated that mathematics was a language like English or Turkish and that it was a common language spoken by the whole world. Quotes from teacher candidates' who came up with the category *mathematics as a universal language* are as follows:

"Mathematics is like language, since it contains symbols that are able to express themselves. Therefore it is a common language that anyone can speak, a universal language." (C44, male).

"Mathematics is like a letter. It is such a letter that it tells you everything with its symbols and numbers so wherever in the world you sent it they can read it and understand it." (C1, female).

Category 11: Mathematics as a figure that requires continuity

In total, there are 3 metaphors represented by 4 (3.6%) teacher candidates under this category. These metaphors are "cat" (2), "love" (1), "instrument" (1). When the metaphors were analyzed, it was found that the teacher candidates who came up with these teachers perceived mathematics as a figure that requires continuity. These teacher candidates pointed out that it is necessary to be continuously involved in mathematics, otherwise its knowledge could be quickly forgotten and that it is a field of science which requires continuous interest. Quotes

from teacher candidates' who came up with the category *mathematics as a figure that requires continuity* are as follows:

"Mathematics is like a cat. However much you take care of it, it is ungrateful. Just a bit of decrease in your interest, it will not even recognize you." (C60, female).

"Mathematics is like a musical instrument because mathematics is ungrateful, like a musical instrument. If one does not pick up the instrument for a week, one loses two weeks of progress. So is mathematics, when we take a break from it, our ability to understand diminishes and we become unfamiliar to it." (C89, male).

Category 12: Mathematics as a figure that is yet to be solved

In total, there are 2 metaphors represented by 3 (2.7%) teacher candidates under this category. These metaphors are "crossword" (2), "aids" (1). When the metaphors were analyzed, it was found that the teacher candidates who developed these metaphors perceived mathematics as a figure that is yet to be solved. These teacher candidates stated that mathematics has many problems to which solutions have not yet been found and that they were still in search for answers. Quotes from teacher candidates' who came up with the category *mathematics as a figure that is yet to be solved* are as follows:

"Mathematics is like a crossword. There are many interesting questions and problems that are yet to be solved. There are problems that have not yet been solved for years in the subject of prime numbers alone." (C63, female).

"Mathematics is like Aids. They both have many details that have not yet been discovered and may never be." (C50, female).

Category 13: Mathematics as a mind-developing figure

In total, there are 3 metaphors represented by 3 (2.7%) teacher candidates under this category. These metaphors are "vitamins" (1), "drug" (1), "brain teaser" (1). When the metaphors were analyzed, it was found that teacher candidates who developed these metaphors perceived mathematics as a mind-developing figure. These teacher candidates pointed out that engaging in mathematics would broaden one's horizon, increase one's level of intelligence and that it would refresh one's outlook on life. Quotes from teacher candidates' who came up with the category *mathematics as a mind-developing figure* are as follows:

"Mathematics is like a brain teaser. When a person is in the middle of solving a brain teaser s/he would be exercising logic on one hand and making calculations on the other; s/he would be doing the same when dealing with mathematics. In this way, we are able to develop our minds and at the same time learn to view life from another angle." (C88, female).

"Mathematics is like vitamins. Taking vitamins benefits a person's mind, and so does mathematics." (C93, male).

Category 14: Mathematics as a figure with a single correct answer

In total, there are 1 metaphors represented by 2 (1.8%) teacher candidates under this category. This metaphor is "maze". When the metaphors were analyzed, it was found that teacher candidates who developed these metaphors perceived mathematics as a figure with a single correct answer. These teacher candidates stated that there were many paths to reach a solution however there is single correct answer. Quotes from teacher candidates' who came up with the category *mathematics as a figure with a single correct answer* are as follows:

"Mathematics is like a maze. There are many paths to take in a maze. By treading some of them we may not be able to reach the exit and by other we may. However, there is only one exit. Such is mathematics; there are many ways to reach a solution but there is only one solution." (C66, female).

"Mathematics is like a maze. There are many labyrinthine routes in a maze; however, only one exit, which is the case with mathematics, as there is a single correct solution." (C103, female).

Discussion and Conclusion

In this study, the perceptions of mathematics teacher candidates were examined through metaphor analysis. In this study, the metaphors developed by mathematics teacher candidates in this study were grouped under 14 categories. According to these categories, about 77% of mathematics teacher candidates perceived mathematics as "Limitless", "Interconnected", "Basically needed", "Fun", "Cumulative", "Indispensable" figure and as a figure which laid the "foundation for other sciences". The remaining 23% perceived mathematics as "Hard-to-understand", "Guiding", "Universal language", "Requiring continuity", "Yet to be solved", "Mind developing" and "Having single correct answer" . According to the results of this study, only the group of mathematics teacher candidates who represented "mathematics as a figure difficult to understand" category had negative perceptions and the mathematics teacher candidates who represent all the remaining categories had positive perceptions with regard to mathematics.

Some of the mathematics teacher candidates in this study defined mathematics as limitless and interconnected figure. Similarly in a study by Kılıç (2011) it was reported that prospective elementary mathematics teachers stated that mathematics subjects were infinite and interconnected. Besides, in a study by Schinck et al. (2008) it was stated that 9th and 10th grade students emphasized that mathematics subjects were interconnected.

Besides, some of the mathematics teacher candidates who took part in this study found mathematics as a fun and enjoyable figure. In similar studies, students, teacher candidates and adults defined mathematics as fun and enjoyable figure (Güveli et al, 2011; Kılıç, 2011; Lim, 1999; Lim & Ernest, 1998; Schinck et al, 2008). However, some of the teacher candidates in this study perceived mathematics as challenging and incomprehensible. Previous studies also revealed similar findings (Güveli et al, 2011; Kılıç, 2011; Lim, 1999; Lim & Ernest, 1998; Schinck et al, 2008; Uçar et al, 2010).

Additionally, some of the mathematics teacher candidates in this study defined mathematics as a basic need figure. In similar conducted studies, it was obtained that mathematics was perceived as a basic need (Güler et al, 2012; Güveli et al, 2011). Another finding revealed in this study is that mathematics teacher candidates regarded mathematics as a universal language and as the foundation of other sciences. Similarly, in a study by Noyes (2006) on mathematics teacher candidates, it was found that mathematics was perceived as a universal language and the foundation for other sciences. Besides in a study by Güveli et al. (2011) on prospective primary teachers, it was obtained that mathematics was perceived as a foundation for other sciences.

Yet another finding of the study is that mathematics teacher candidates hold the view that mathematics is a branch of science which requires effort and permanence. This finding is line with the findings of other related studies (Güveli et al, 2011; Lim, 1999; Lim & Ernest, 1998; Schinck et al, 2008). Unlike the results obtained in similar studies, another result found in this study is that mathematics teacher candidates defined mathematics as a cumulative, an indispensable, a guiding and a mind-developing figure.

In conclusion, it was seen that mathematics was related with various concepts in this study, which aims to examine the metaphors of mathematics teacher candidates for the concept of mathematics. Although most of the teacher candidates who joined the study have positive opinions about mathematics, some of them find mathematics hard to comprehend. Öztürk (2007) argues that perceptions and attitudes of teachers about the concepts that they are liable to teach gives clues about how they will transfer those concepts. Thus, it can be suggested that teacher candidates with positive opinions about mathematics can teach their students mathematics in their professional lives. On the other hand, it can be stated that teacher candidates who find mathematics difficult to comprehend are going to face many obstacles in their professional lives due to this negative attitude they have developed about the lesson they are going to teach in the future. For this reason, lessons such as mathematics history and mathematics nature shall be incorporated into the curricula in faculty of education beside the theoretical lessons in order for the teacher candidates who do not like mathematics or who experience difficulty in this lesson to change this negative attitude about mathematics.

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