



## A Metaphor Analysis of Mathematics Teacher Candidates' Connotations about the Concept of Mathematics

### Matematik Öğretmeni Adaylarının Matematik Kavramıyla İlgili Çağrışımlarının Metafor Analizi

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#### Abstract

In this study, the connotations of the concept of mathematics belong to the teacher candidates who have participated in the formation certificate program in different years were examined. In the study, 32 teacher candidates who graduated from the mathematics departments of the Faculty of Arts and Science in 2014-15 and 27 teacher candidates in the Faculty of Arts and Sciences who were studying in 3rd and 4th grades in 2017-18 participated. The research is a qualitative research with phenomenological design. A questionnaire containing two open-ended questions to determine the connotations about the concept of mathematics and the causes of these connotations was given and the data were analysed by content analysis method. The 150 connotations of teacher candidates were classified according to the categories determined in 8 different studies examined in the literature and these categories are classified within themselves then the themes of Definition, Description and Emotion are determined. It was observed that teachers' candidates emphasized mathematics as a model trying to understand life and its contents and as a necessary tool for life.

**Keywords:** teacher candidates, metaphor analysis, connotations.

#### Cited:

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**Öz**

Bu çalışmada, formasyon sertifika programına farklı yıllarında katılan matematik bölümü öğretmen adaylarının matematik kavramı hakkında sahip oldukları çağrışımlar incelenmiştir. Araştırmaya 2015 yılında fen edebiyat fakültelerinin matematik bölümlerinden mezun olmuş 32 öğretmen adayı ile 2018 yılında fen edebiyat fakültesinde halen 3. ve 4. Sınıflarda okumakta olan 27 öğretmen adayı katılmıştır. Araştırma olgu bilim deseninde nitel bir araştırmadır. Katılımcılara, matematik kavramı hakkındaki çağrışımları ve bu çağrışımların nedenlerini belirlemeye yönelik iki açık uçlu soru içeren bir anket formu verilmiş ve elde edilen veriler içerik analizi yöntemiyle analiz edilmiştir. Öğretmen adaylarının sahip oldukları 150 çağrışım alan yazında incelenen 8 ayrı çalışmada belirlenen kategorilere göre sınıflandırılmış ve bu kategoriler de kendi içinde sınıflandırılarak Tanım, Betimleme ve Duygu temaları belirlenmiştir. Öğretmen adaylarının, matematik hakkında hem hayatı ve içindekileri anlamaya çalışan bir model hem de yaşam için gerekli bir araç olmasına vurgu yaptıkları görülmüştür.

**Anahtar sözcükler:** Öğretmen adayları, metafor analizi, çağrışımlar.

**Atıf:**

Ayhan, İ. ve Sinecen, O. (2019). Matematik öğretmeni adaylarının matematik kavramıyla ilgili çağrışımlarının metefor analizi. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi*, 47, 395-421. doi: 10.9779/pauefd.580110

## Introduction

Mathematics is one of the concepts in which individuals have the most meaning in their lives. Both in-school and out-of-school environments are effective in the formation of these meanings. Educational research has shown that the students' emotions, attitudes and beliefs shaped in the beginning of their educational lives affect the remaining educational experiences. Positive or negative attitudes towards mathematics are influential on the student's career and educational choices. Educational research has shown that attitudes can change with effective educational practices (Koca, 2010). In this context, metaphor studies in understanding the feelings, attitudes and beliefs of the students about the concept of mathematics are guiding (Yob, 2003).

The definition of metaphor in the literature is defined as;

- transfer or transport the meaning (Kılıç, Yanpar, 2013),
- trying to establish new connections between concepts by associating the unknown with the known (Erdoğan, 2014)
- an indirect explanation of a concept by means of another object or concept (Ünsal et al., 2016).

To reveal the metaphors of a concept a questionnaire containing "It is like... Because..." is used (Koca, 2010). For mathematics, a student using the metaphor that a lion hunting a sleeping antelope explained the underlying reason for using this metaphor as follows: "I am an antelope here and want to explain my helplessness in the face of mathematics using this metaphor"(Latterall and Willson, 2016). In order for a case to be a metaphor, there must be the subject, the source of the metaphor and a relationship between the subject and the source (Saban, 2004). In the previous example, the subject of metaphor is mathematics, the lion hunting the sleeping antelope is the source, and the relationship between its source and its subject is that the student feels like antelope hunted while sleeping in the face of mathematics. We can also convey our feelings, attitudes and beliefs about a concept through connotations.

The definition of the concept of connotation is given by the Turkish Language Association "as a result of the connections made between the behaviours, thoughts and concepts under the effect of the unity of space and time, the event of attracting the other to consciousness when one of them enters into the field of consciousness". The fleas experiment given as an example of learned helplessness can be given as an example of inter-behavioural connotation. In this experiment, fleas are placed in a cylindrical glass fan over a sheet that is heated from the bottom. As the sheet heats up, the flea bounces upwards each time in the glass fan. An obstacle is placed on the glass fan at a height of 50 cm. Flea learns to jump up to 50 cm from the top of the hair after striking the obstacle. Although the obstacle is removed, the bounce height of the flea from the heated sheet surface remains the same. The consciousness created by flea after the impact of the obstacle is a connotation between the behaviour of ascension and the behaviour of obstacle avoidance. An example of the connotation between thoughts is that the ellipses of Apollonius of Perge remind Kepler's planets that make planar ellipse movement around the sun. Connotations are the first stage of producing metaphors. If we explain this situation with an example between concepts ice cream for the concept of the individual that appears in the mind of the event on the ice cream bar written free that gives free ice cream. In this case, free concept

is a connotation that overlaps with the concept of ice cream in the mind of the individual and this connotation can match the individual with the metaphor of "winning the big bonus from lottery". Thus, the metaphor of the emotion formed through the connotation is realized.

Examining the metaphors or connotations that students produce for mathematics enables to understand both the quality of mathematics knowledge and the quality of teaching. The abstract structure of mathematical concepts and the necessity of the indirect transfer of these concepts emphasize metaphors and connotations as a strong mental model in understanding and explaining an abstract, complex or theoretical phenomenon in mathematics teaching (Güveli et al. 2011; Güler et al., 2012). The mathematics teacher's feelings, attitudes and beliefs about the mathematics and its all elements are directly effective on mathematics teaching (Güler, 2011). To develop a teacher's thoughts, images and practices using metaphors or connotations is possible (Filiz, 2018). In this context, it is important to examine via metaphors or connotations the conceptual perceptions of teacher candidates who will become secondary mathematics teachers in the future (Güler, 2011). Furthermore, to classify the metaphors produced by students who have different levels of education from the secondary schools to the university about the concept of mathematics is also important. National and international studies investigating the metaphors produced by students of different age levels about the concept of mathematics have been randomly selected in the literature. These selected studies are as follows: (Güveli et al., 2011; Erdoğan et al., 2014; Keleş et al., 2016; Koca, 2010; Schinck et al., 2008; Latterell and Wilson, 2017; Güner, 2013; Kılıç and Yanpar, 2013). In these studies, Güveli et al. (2011) with the classroom teacher candidates, Erdoğan et al. (2014) with the elementary school mathematics teacher candidates, Keleş et al. (2016) with the preschool teacher candidates have been studied. Among the selected studies, there are studies investigating the metaphors produced by students of different groups about the concept of mathematics. Examples of these are: Koca (2010), secondary school, high school students, elementary school mathematics teacher candidates and university students studying at the same university. Schinck et al. (2008) 9th and 10th grade high school students, Latterell and Wilson (2017) with classroom and elementary mathematics teacher candidates, Güner (2013) classroom, social studies, elementary school mathematics teacher candidates, finally, Kılıç and Yanpar (2013) have worked on metaphors about the math concepts were produced by classroom teacher candidates studying in Belgium and Turkey. In these selected studies, the metaphors produced about the concept of mathematics and the categories and themes in which these metaphors remain have been re-classified by the researchers of this study.

The aim of this study is to determine the metaphors produced by students who have different levels of education from the secondary schools to the university about the concept of mathematics, and also to find new themes representing these categories by identifying the categories that include these metaphors. Then, it is to determine the connotations about the concept of mathematics of students participated in formation certificate program in 2015 and 2018 and classify these connotations according to the determined themes.

The research questions that guide this study are given below:

1. The metaphors produced about the concept of mathematics in selected studies are extensively contained within which category and theme?

2. The connotations produced by mathematics teacher candidates who participated in the formation certificate program in different years are extensively contained within which category and theme ?

### **Method**

This study is a study of phenomenology pattern in qualitative research methods. Phenomenology studies focus on the main differences in how the phenomenon is experienced. With the help of researches carried out in the phenomenology pattern, it is tried to understand and explain the relations between the individual and the things he / she is trying to learn (Çepni, 2014). In this context, the perceptions of mathematics teacher candidates in the formation certificate program related to the concept of mathematics have been revealed and interpreted.

### **Participants**

This study consisted of 19 female and 13 male students in 2014-2015 academic year and 17 female and 10 male teachers from the Mathematics Department of the 2017-2018 academic year were enrolled in formation certificate program. Prospective teachers in the 2014-2015 academic year have bachelor degree and seven of them have teaching experience in institutions other than Ministry of National Education between 2 and 10 years. In the 2017-2018 academic year, the prospective teachers who participated in the research are still students of department of the mathematics of Faculty of Art and Science and the youngest of them are in the 3rd grade level. Also only one student has been working for 5 years. Both groups were chosen as the study group because they had an understanding and experience beyond the basic knowledge about the concept of mathematics. Whether these two groups' connotations about the concept of mathematics change according to the year of participation variable in the formation certificate program or gender variable is important to see the change in the meanings attributed to the concept of mathematics of mathematics teacher candidates.

### **Data Collection Tools**

The data of this study were collected from volunteer participants by means of answers to a questionnaire including open-ended questions as well as individual information such as working year and gender. These open-ended questions are as follows:

“What is your opinion about mathematics? What kind of connotation does it make you? Explain why”.

### **Procedure and data analysis**

The research data were collected from the responses of the participants to the questionnaire based on the volunteer basis after the required permissions and were taken within one lesson hour (45 minutes) of the Special Teaching Methods course of the Formation Certificate Program in 2014-2015. After three years later, the research data were collected from the responses of the volunteer participants to the questionnaire questions after the necessary permissions were taken within one lesson hour (45 minutes) of the Abstract Algebra course conducted in the Faculty of Arts and Sciences with the different teacher candidates of the 2017-2018 academic year.

Data were analysed in two stages. First of all, the articles which were prepared by the method of metaphor analysis about the concept of mathematics in the literature, were classified according to the school type and sections of the participants and eight different articles were determined with the widest type of place where the participants were educated. These articles

are referred to as literature (Güveli et al., 2011; Erdoğan et al., 2014; Keleş et al., 2016; Koca, 2010; Schinck et al., 2008; Latterell and Wilson, 2017; Güner, 2013; Kılıç and Yanpar, 2013 ). The categories obtained from the studies of the literature and the metaphors associated with these categories were determined. 22 different categories representing metaphors were identified in the literature. These categories have been re-classified under the themes of Definition, Description and Emotion. While creating the sub-categories of the definition theme, the definitions of Mathematics discussed in the study of Khait (2005) were used. Subjective and objective judgements which are not part of the definition of mathematics but which reveal their own characteristics are defined in a way to constitute sub-categories of Subjective Description and Objective Description of the description theme. In addition, metaphors indicating positive or negative attitudes were examined in a way to be compatible with the study of emotion (Kılıç & Yanpar, 2013)

In the second phase of the study, descriptive analysis of the preconceptions produced by the teacher candidates was made and the connotations produced by the participants, which may be more than one are coded and 154 codes were found. These codes, which are representative of the connotations, are classified according to 22 categories obtained from the literature. This process was carried out by two researchers who conducted the research. To ensure the reliability of the study, the 3rd researcher classified the codes produced by the first two researchers according to the categories determined in the literature (Schinck et al., 2008). Then, the matches made by the researchers and the matches of the expert researcher were compared and the consensus and number of opinions were determined. The reliability of the research was found to be 82.4% by using Miles and Huberman's (1994) formula  $\text{Reliability} = \frac{\text{Consensus}}{\text{consensus} + \text{disagreement}}$ . The category of each code that caused incompatibility between the teacher candidates' questionnaires was re-examined by the expert researcher and the reliability coefficient of the research was found to be 96%. Considering that the desired reliability is achieved in cases where it is 90% or more according to Miles and Huberman (1994), a 96% consensus on the reliability of the study can be seen as sufficient in terms of the reliability of the study. The expert researcher proposed to combine some metaphor representatives. In this context;

- Metaphor's representatives of mathematics that require hard work and continuity are combined with mathematics as a process requiring action due to the unity of meaning.
- Metaphor's representatives of mathematics as the basis and assistant of other sciences and mathematics as the most important discipline are also combined because their emphasis is complementary.
- Metaphor's representatives of mathematics as a guiding figure with mathematics as a necessary tools for life are combined because of the common characteristics of the metaphors produced.
- Metaphor's representatives of mathematics, which consists of many subjects and multiplied by addition and the mathematics as a related figure are combined, because the metaphors produced cannot be clearly separated from each other.

Thus, metaphor's representatives and codes were re-determined, 18 metaphor's representatives and 150 codes have been obtained. We have shown that the codes by which metaphors in selected articles and mathematics teacher candidates' connotations are expressed in

a metaphor's representative. We have considered that the metaphor's representative entitled mathematics as an unlimited figure. Of eight studies selected from literature, only some metaphors in the studies (Erdoğan et al., 2014; Latterell & Wilson, 2017; Kılıç & Yanpar, 2013) are found as code within this metaphor representative. These codes can be listed as: "Ocean, sea, space, infinity, sky, big plane, well, black, universe, constellation, cliff in (Erdoğan et al., 2014)", ocean, sun, endless spider web in (Latterell & Wilson, 2017) and discovering the new world, one is a puzzle that is passed to the new one, endless road, a new world that you will discover, a long journey in (Kılıç & Yanpar, 2013).

Moreover, the connotations of the mathematics teacher candidates participating in the 2015 formation certificate program as code within the same metaphor representative can be listed as follows: Mathematics is a universal and infinite concept (FE18), is to produce, and then is to produce again using the product (FE23), has the greatest contribution to our perception of the universe by formulating of physics, chemistry, astronomy (FE24), is a universal infinity and a large area (FE28) and endless sea to explain the functioning of the universe (FE32).

The connotations of the mathematics teacher candidates participating in the 2015 formation certificate program as code within the same metaphor representative can be listed as follows: Math is infinity (GE7), is a completely different world that cannot be understood without experiencing mathematics (GE14), Math is a journey to the unknown as well as a miraculous universe that eliminates the mystery of the unknown and an immense way to open new horizons (GE21), bottomless well (GE26). Examples of metaphors and connotations of other metaphor representatives are given in section

## **Results**

The metaphors created by the participants with different school types and departments on the concept of mathematics and the themes and categories obtained from these metaphors were examined in the literature and it was seen that the categories could be classified under the definition, description, emotion themes.).

The metaphors of the field studies and the participants of different types of schools about the concept of or mathematics "and the themes and subcategories obtained from these metaphors are presented in Table 1.

**Table 1. The distribution of the themes and subcategories of the concept of mathematics according to school types and departments**

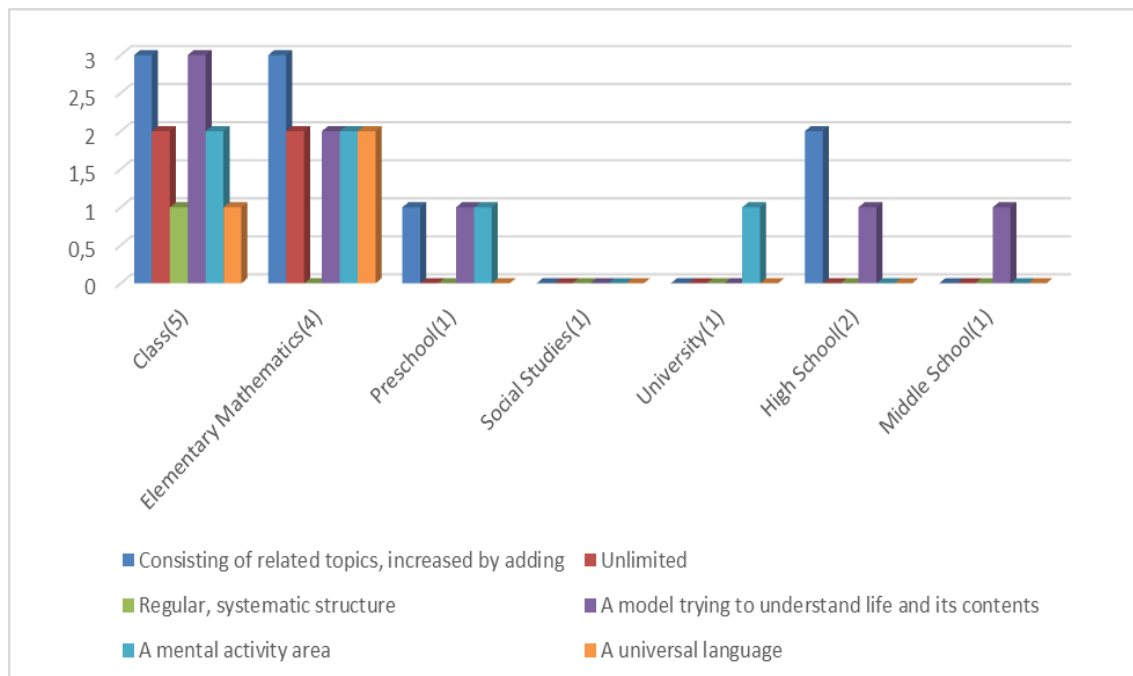
THEME	CATEGORIES	Classroom		Mathematics				Preschool	Social Studies	University	High School	Middle School			
		1	3c	4c	8b	8t	2	3m	4m	6m	5	4ss	6u	6hs	7
DEFINITION	Consisting of related topics, increased by adding	X			X	X	X	X	X				X	X	
	Unlimited				X	X	X	X							
	Regular, systematic structure	X													
	A model trying to understand life and its contents	X	X		X			X	X	X			X		X
	A mental activity area	X			X	X	X			X		X			
	A universal language		X				X	X							
DESCRIPTION	Only those who know how to fight can achieve	X			X		X								
	Being an action that requires strict and steady work	X			X	X	X	X	X			X	X	X	X
	with ups and downs		X		X										
	People cannot avoid learning		X		X	X									
	Guiding						X								
	Quick to do while doing												X		
	A necessary tool for life	X	X	X	X	X	X	X	X	X	X			X	X
	Self-repeating applications				X										
	A figure with one correct answer				X	X						X			
	Contains unsolved problems						X								
OBJECTIVE	An important phenomenon that is both basic and helpful for other sciences	X					X	X	X						
EMOTION	Exciting, fun, easy, beautiful, enjoyable	X	X	X	X	X	X	X	X	X			X		X
	Difficult, boring, self-helpless, meaningless effort	X	X	X	X	X	X			X	X	X	X	X	X

Explanation: The number of selected papers used in the table is shown as follows: [1] (Güveli et al., 2011), [2] (Erdoğan et al., 2014), [3] (Latterell & Wilson, 2017), [4] (Güner, 2013), [5] (Keles et al., 2016), [6] (Koca, 2010), [7] (Schinck et al., 2008), [8] (Kılıç & Yanpar, 2013).



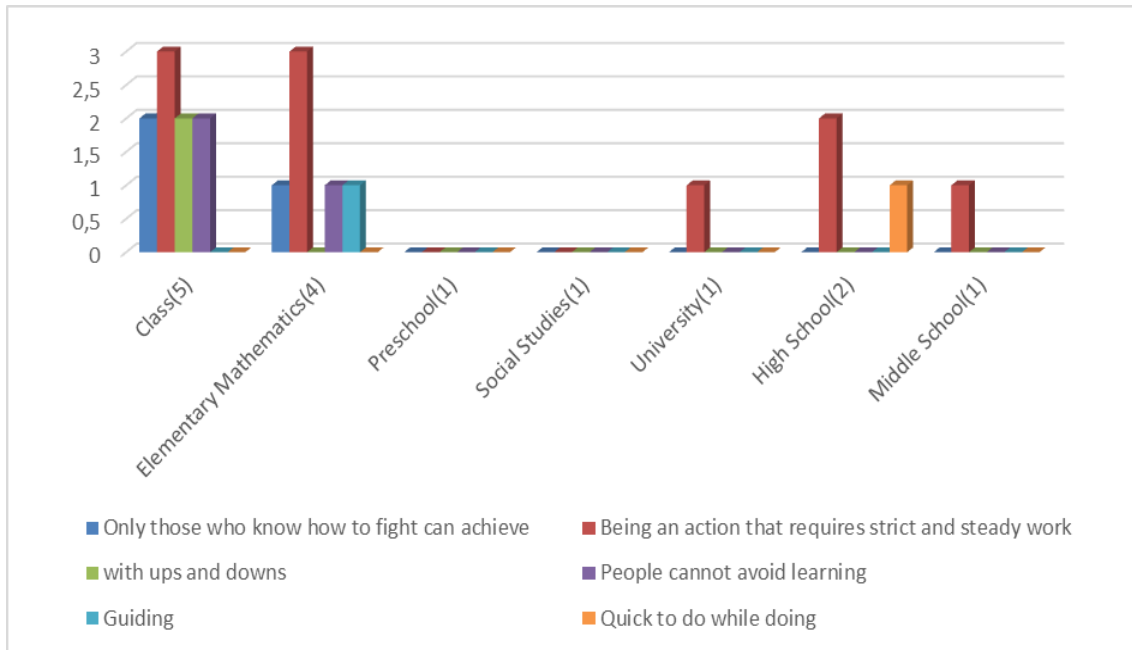
When Table 1 is examined, it is seen that the participants of the literature study focus on the concept of mathematics theme “Definition”, *consisting of related topics increased by adding, a model trying to understand life and its contents, a mental activity area*. In the theme of subjective description *being an action that requires strict and steady work*, and in the theme of objective description, *a tool for life* is emphasized. In the theme of emotion, both positive and negative attitudes are emphasized.

In addition, the frequency of addressing the categories of all themes according to the place where the participants were educated is examined in Table 1. In this context, according to the place where the participants were trained, the frequencies of the categories of the definition theme were determined from the Table 1 data and visualized by the following figure. In the following figure, the numbers given in parentheses next to the school type define the total number of programs in which the participants of the field studies study.



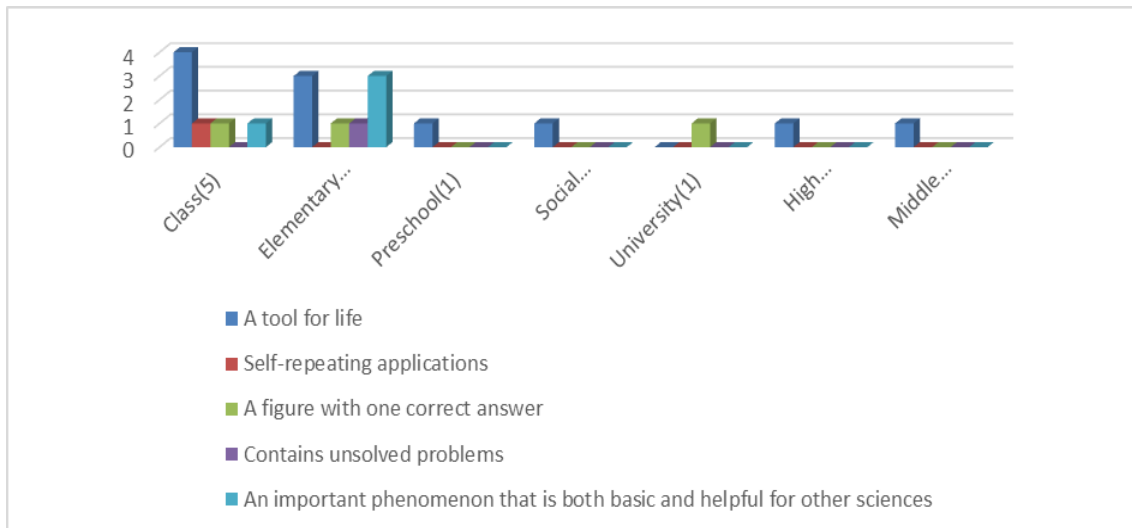
**Figure 1.** The frequencies of the participants in the categories of the definition theme according to the place they were trained.

When Figure 1 is examined, it is seen that primary school teachers and elementary school mathematics teachers have intensified the categories in the definition theme. The frequencies of the subjects related to the Subjective Identification theme were determined from the Table 1 data and visualized by the figure below.



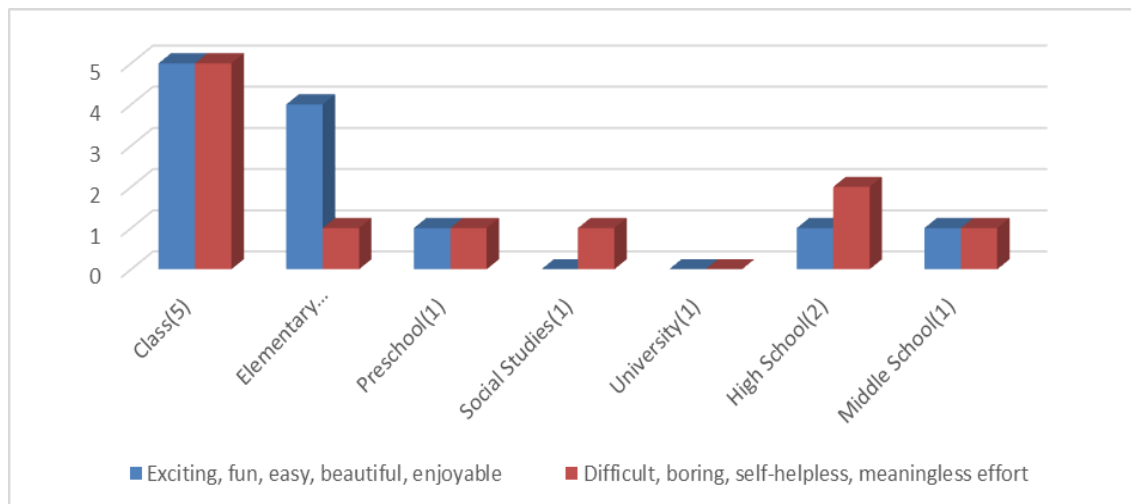
**Figure 2. The frequency of giving the categories of the Subjective Descriptive Theme by the places where Participants educated**

In Figure 2, only high school students emphasized the need to be fast when making solutions about the concept of mathematics. According to the place where the participants were trained, the frequencies of the theme of the object description theme were determined from the Table 1 data and visualized by the following figure.



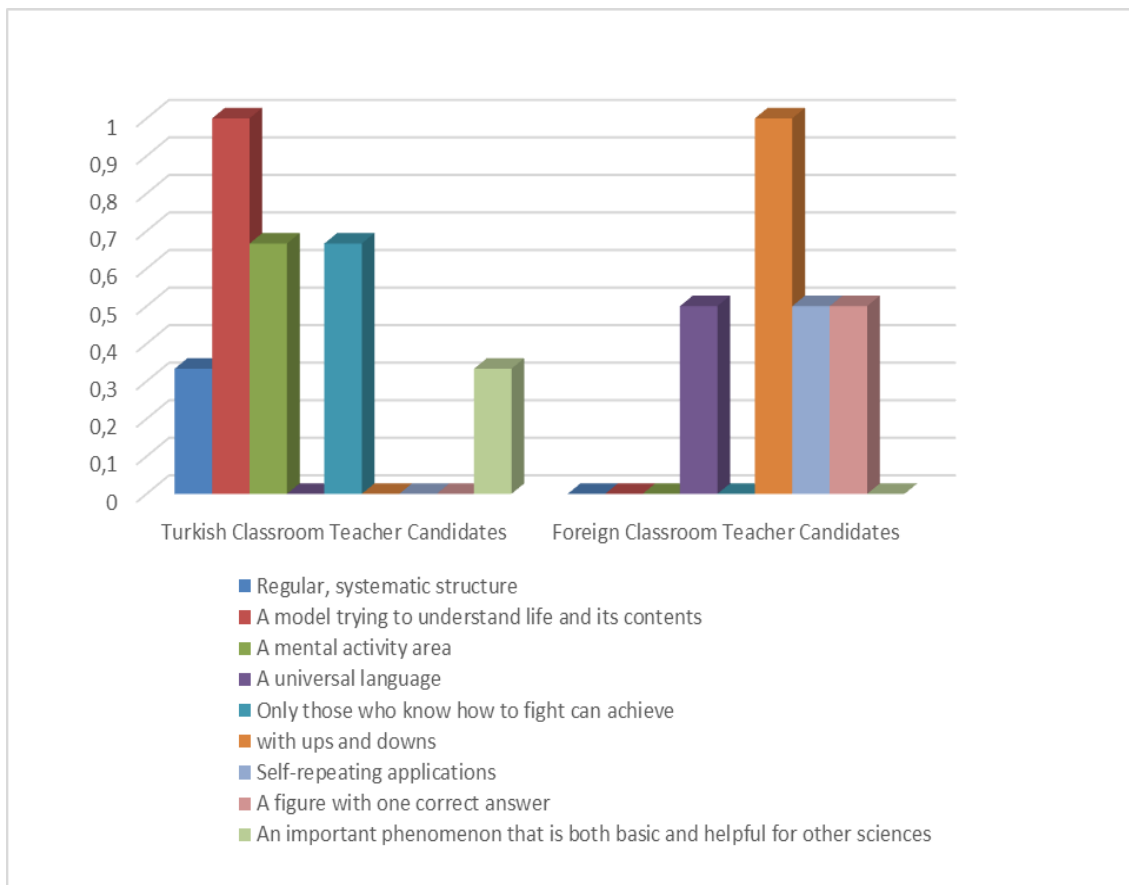
**Figure 3. The frequency of the categories of the objective description of the theme according to the place where the participants received training.**

When Figure 3 is examined, it is seen that a single category with a correct answer for the objective description theme is emphasized by 3 different groups of participants. According to the place where the participants were trained, the frequencies of the theme of the emotion theme were determined from the Table 1 data and visualized by the figure below.



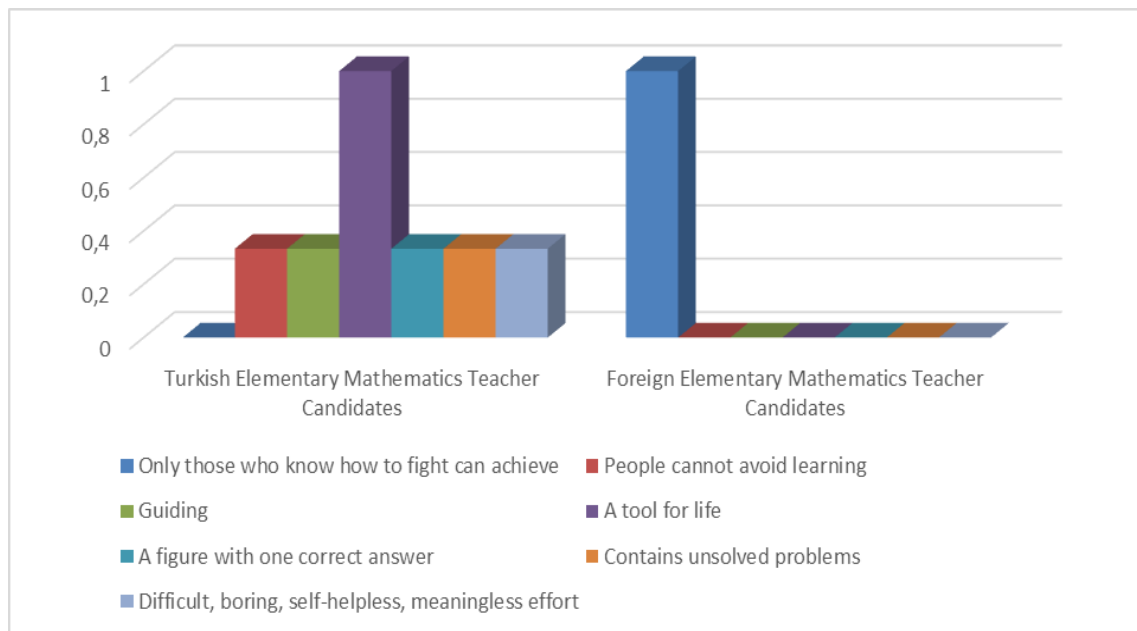
**Figure 4. Frequency of Emotion Contact Categories by place where the participants received training.**

When Figure 4 is examined, it is seen that primary school, preschool and middle school students have equal and positive attitudes. Metaphoric discrepancies of Turkish and foreign students about mathematics concept were examined based on 3 different school types. For each type of school, the participants of the field study were categorized according to their nationality. The different types of participants with the same type of school have been investigated in all categories, according to emphasis difference. The results on the type of school are visualized with the help of the following figures. According to the nationality of the teacher candidates, metaphorical perception discrepancies are given as follows. In Table 1, participants with 1, 4s and 8t codes are Turkish nationals, 3s, and 8b coded participants represent students who are foreign nationals.



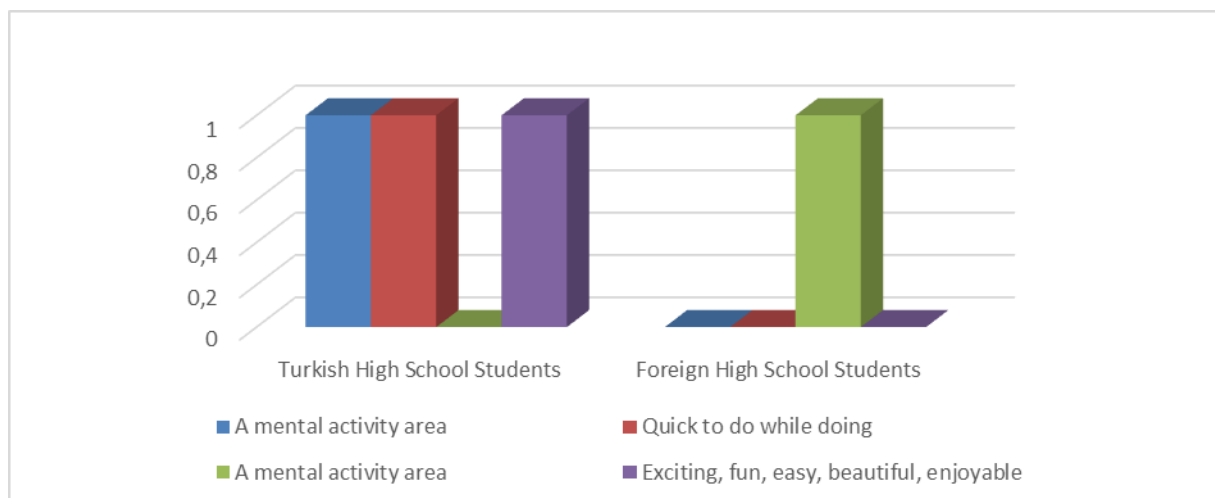
**Figure 5. Metaphoric perception discrepancies according to the nationality of prospective teachers**

The ratio of Turkish pre-service primary school teachers to the total number of studies in the category A model trying to understand life and its contents is 1. In other words, this category has been cited in each of the 3 separate studies in which Turkish pre-service primary school teachers are participating. However, this category has not been mentioned in any study in which foreign teacher candidates are participating. Metaphorical perception discrepancies according to nationality of prospective mathematics teachers are given as follows. In Table 1, participants with 2, 4m and 6m codes are Turkish nationals and 3m coded participants represent the Primary Mathematics Teacher Candidates.



**Figure 6. Metaphoric perception discrepancies according to the nationality of prospective mathematics teachers**

While the category of *a tool for life* was found to be incompatible for Turkish nationals, the category of *only those who know how to fight can achieve* metaphoric perception incompatibility for foreign participants. In addition, the single correct answer figure category was cited by only one participant in 3 different studies and it differs from the foreign participants with a rate of 0,3. Metaphoric discrepancies of high school students according to their nationality are given as follows. In Table 1, participants with 61 code are Turkish nationals and 7 coded participants represent foreign high school students.



**Figure 7. Metaphoric perception discrepancies of high school students**

For the Turkish participants, the category *quick to do while doing*, for foreign participants the category of *a tool for life* caused metaphoric perception mismatch. The frequencies of the associates of the Mathematics Department who participated in the Formation Certificate Program in 2015 and 2018 about Maths were classified according to the themes and

subcategories obtained from the studies in the literature and the data obtained are presented in Table 2.

**Table 2. Distribution of connotations of teacher candidates according to gender, year of participation in certificate program, metaphor classification made by researchers**

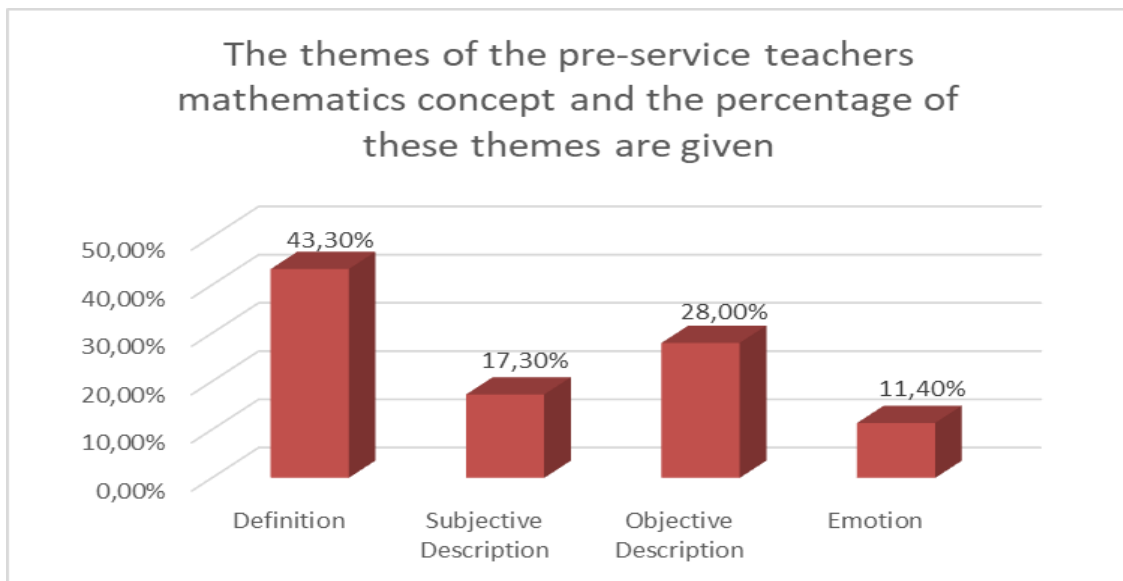
THEME	CATEGORIES	2015		2018		TOTAL
		f <sub>WOMAN</sub>	f <sub>MAN</sub>	f <sub>WOMAN</sub>	f <sub>MAN</sub>	
DEFINITION	Consisting of related topics, multiplying by adding	2	3	1	0	6
	Unlimited	1	3	2	2	8
	Regular, systematic structure	4	2	0	1	7
	A model trying to understand life and its contents	6	6	7	3	22
	A mental activity area	8	5	2	2	17
	A universal language	1	3	1	0	5
	<b>Subtotal (f)</b>	22	22	13	8	65
	<b>Subtotal (%)</b>	44,9	61,1	30,2	36,3	43,3
DESCRIPTION	Only those who know how to fight can achieve	5	1	7	5	18
	Being an action that requires strict and steady work	1	0	0	0	1
	with ups and downs	1	0	0	0	1
	People cannot avoid learning	0	2	2	0	4
	Quick to do while doing	2	0	0	0	2
	<b>Subtotal (f)</b>	9	3	9	5	26
	<b>Subtotal (%)</b>	18,3	83,3	21	22,7	17,3
	A necessary tool for life	10	6	8	5	29
	Self-repeating applications	0	0	0	0	0
	A figure with one correct answer	2	2	0	0	4
	Contains unsolved problems	0	0	0	0	0
	An important phenomenon that is both basic and helpful for other sciences	2	3	2	2	9
<b>Subtotal (f)</b>	14	11	10	7	42	
<b>Subtotal (%)</b>	28,5	30,5	23,2	31,8	28	
EMOTION	Exciting, fun, easy, beautiful, enjoyable	1	0	8	2	11
	Difficult, boring,	3	0	3	0	6

self-helpless, meaningless effort					
<b>Subtotal (f)</b>	4	0	11	2	17
<b>Subtotal (%)</b>	8,1	0	25,5	9	11,4
<b>Grand Total (f)</b>	49	36	43	22	150
<b>Grand Total (%)</b>	32,6	24,1	28,6	14,7	100

When the data in Table 2 are examined, teacher candidates who participated in the program in 2015 had a total of 150 (56.7%) and teacher candidates who participated in the program in 2018 had 65 (43.3). In teacher candidates who participated in the program in 2015 produced, 44 and 37 connotations while teacher candidates who participated in the program in 2018, 21 and 31 connotations in the Description and Descriptive theme. As it is understood from this point, the teacher candidates of 2015 produced more connotations in teacher candidates who participated in the program in 2018 in both connotations and definition and description. In the theme of emotion, teacher candidates who participated in the program in 2018 passed the teacher candidates who participated in the program in 2015 who produced 4 connotations by producing 13 connotations. In this result, it can be shown that both the average age and the private sector work experience of the teacher candidates in 2015 is higher than the teacher candidates in 2018. In addition, considering the number of connotations produced by sex, it can be seen that women (92) are clearly ahead of men (58).

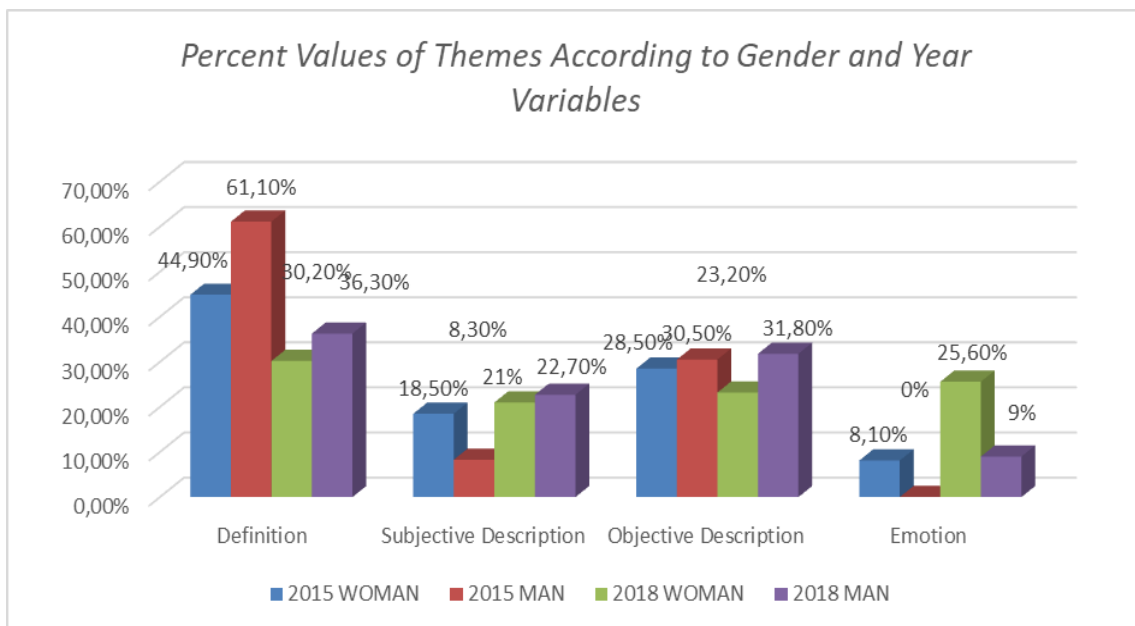
When table 2 is examined according to the frequency of connotations, it is observed that there is no connotation about the concept of mathematics in the self-repeating and contains unresolved problems categories. In addition, while only 2 female teacher candidates in the Quick to do while doing category produced a connotation, only one female teacher candidate from the 2015 participants in the requires strict and steady work and with ups and downs categories produced connotations. In the category of a figure with one correct answer, only 2015 teacher candidates produced connotations. Only female teacher candidates produced connotations in the difficult, boring, self-helpless, meaningless effort category, while male teacher candidates did not produce connotations. In the category where people cannot avoid learning, 2015 female teacher candidates and 2018 female teacher candidates produced an equal number of (2) connotations.

When the categories are examined in general, the highest connotation rate is 29 in a tool for life category. This is followed by a model trying to understand life and its contents category with 22 connotations. With the 18 connotations, only those who know how to fight can achieve, with 17 connotations a mental activity area and with the 11 connotations, exciting, fun, easy, beautiful, enjoyable category took connotations. The themes of the teacher candidates' mathematics concept and the percentage of these themes are given in Figure 8.



**Figure 8. Percentages of themes and themes obtained**

When Figure 8 is examined, it has been observed that 43.3% of the connotations produced belong to the Definition theme, 17,3% to the Subjective Description theme and 11,4% to the Emotion theme.

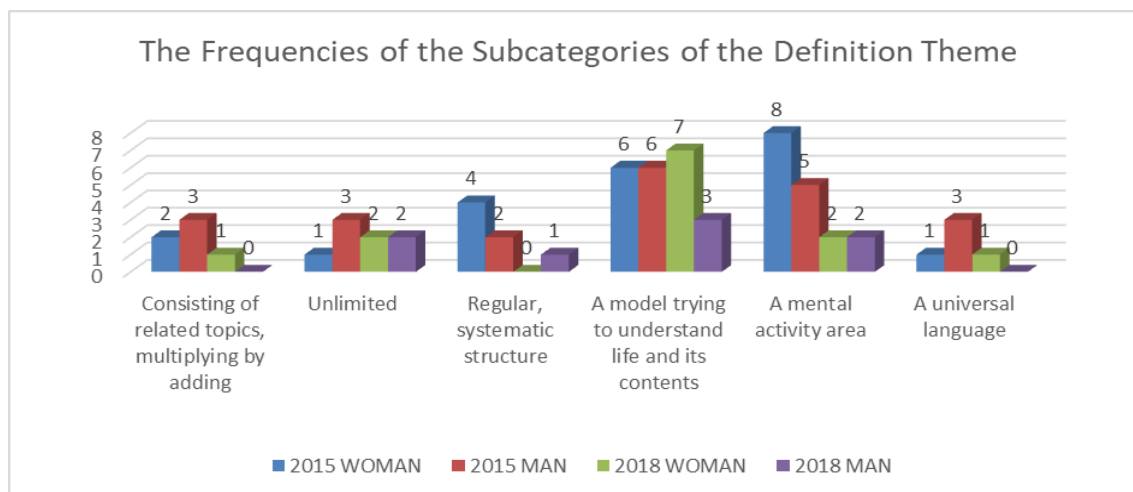


**Figure 9. Percent values of themes according to gender and year variables**

Figure 9 shows that the percentage of teacher candidates in 2015 is higher than the number of teacher candidates in 2018 according to the percentage of teacher candidates in the total connotation of all themes they produce. In addition, teacher candidates of 2018 in all categories, except for female teacher candidates, are more likely to produce connotations than teacher candidates of 2015.

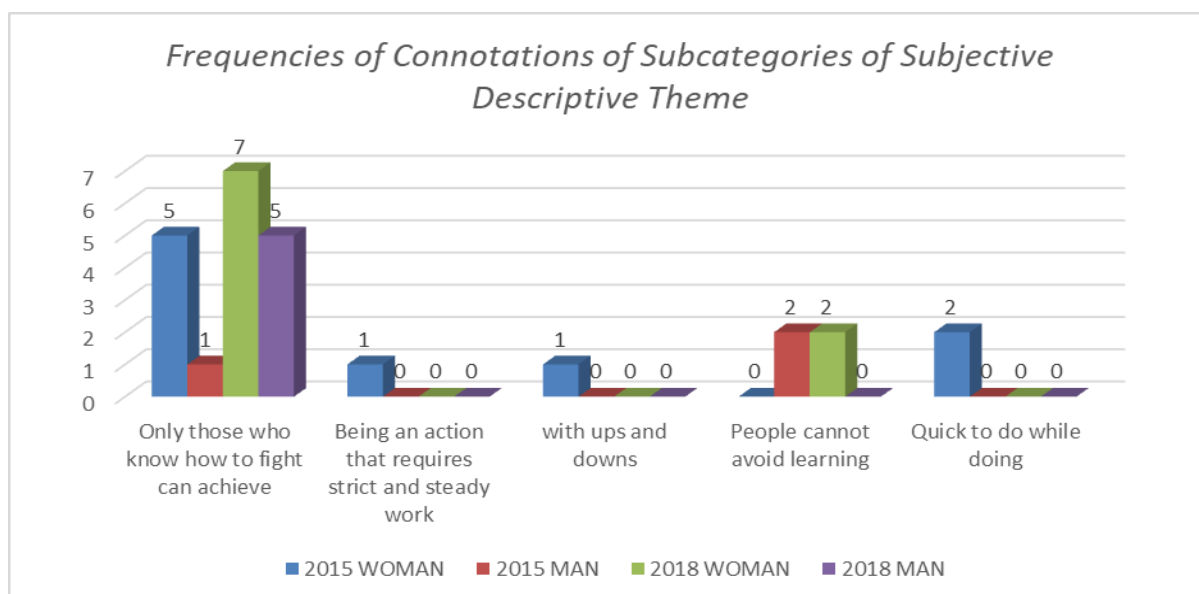


When the definition theme is compared with other themes in terms of connotations rate, the most connotations rate is 61.1% in 2015, while the lowest rate of connotations is 30.20%. The subject of Subjective Descriptive theme and Objective Descriptive theme received almost the same proportion connotations of candidates. However, when the theme of emotion is compared with other themes, the highest rate is 25.6% for female teacher candidates, and the lowest rate of connotation is 0% for 2015 male teacher candidates.



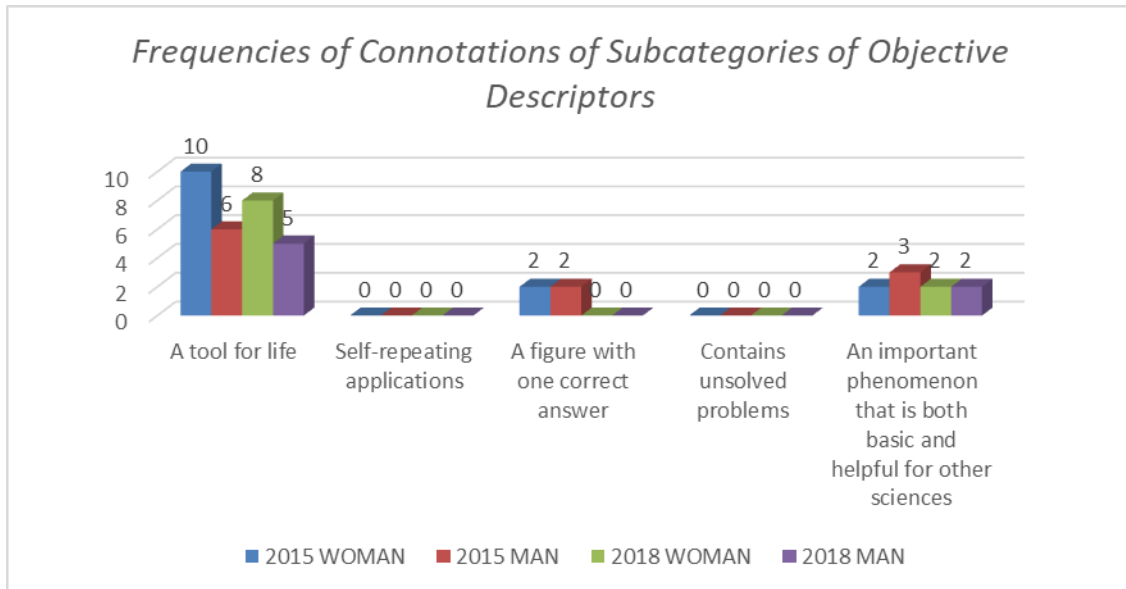
**Figure 10.** Frequencies of connotations of subcategories of definition of teacher candidates according to gender and year variables

In Figure 10, the frequencies of the subcategories of the Definition theme are given. While teacher candidates of 2015 produced 4 or more connotations in almost every category, teacher candidates of 2018 produced only one connotation in 3 different sub-categories. The categories in the definition theme are a model trying to understand life and its contents and a mental activity area.



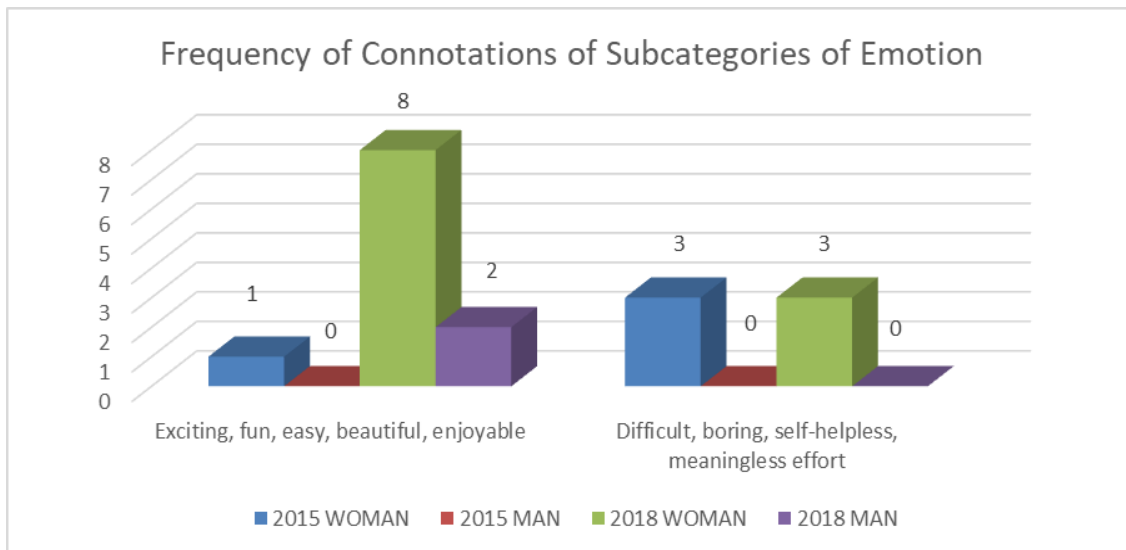
**Figure 11.** Frequencies of connotations of subcategories of subjective descriptive theme according to teachers' gender and year variables

When Figure 11 is examined, they refer to sub-category *only those who know how to fight can achieve* in subjective description.



**Figure 12. Frequencies of connotations of subcategories of objective descriptors by gender and year variables of teacher candidates**

Figure 12 shows the heavily highlighted subcategories a tool for life and an important phenomenon that is both basic and helpful for other sciences.



**Figure 13. Frequency of connotations of subcategories of emotion contact according to gender and year variables of teacher candidates**

In Figure 13, teacher candidates produced both positive and negative connotations about mathematics. It is observed that women are more powerful than men in expressing their attitudes about mathematics.

## Theme and Subcategories of Metaphor and Connotations

Metaphors from the articles examined in the literature and the connotations formed by the participants of this study are presented in a way that is compatible with the theme and subclass classification. According to this, the metaphor and connotation examples of categories are given below. FE27 shows the 27th male mathematics teacher candidate who participated in the research in 2014-15, GK16 shows the 16th female mathematics teacher candidate who participated in the research in 2017-18 academic year.

Maths as an image that is related to each other, adding and multiplying:

- Math is like a rainbow. Because it contains every colour (Koca, 2010)
- Math makes it possible to make a lifetime calculation and to get new knowledge in theoretical work (FE27)

Unlimited:

- Math is like a circle. Because you think you know everything about it but there is something you still don't know (Kılıç & Yanpar, 2013).
- Mathematics is an endless way to reach the unattainable, to push the boundaries of thoughts, to open up new horizons that enable secrets and unexplained ones to be presented in a reasonable way to the mind (GE21)

Regular Systematic Structure:

- Math is like Football game. Because it is a systematic game with rules (Guveli et al., 2011).
- A systematic order of mathematical numbers (FK5)

A model trying to understand life and its contents:

- Math is like a car engine. Because it is vital for the car, such as motor (Keles et al., 2016).
- Mathematics is at the basis of the universe, all the concepts in the world can be explained by mathematics (FK14).

Mental Activity Area:

- Mathematics is an extreme way of thinking. It doesn't involve changing the places but thinking with our mental abilities (Kılıç & Yanpar, 2013).
- There is no single purpose in mathematics, the most important goal is to improve the ability to think (FE24).

A Universal Language:

- Mathematics is like the language we describe in our lives through physics, chemistry and biology (Latteral & Wilson, 2017).
- A language that seeks to understand the relationships between nature, living things, objects is a universality in which people can understand, interpret, express new ideas by means of free will, and can measure their own accuracy (FE23).

Examples of metaphor and connotation related to subjective description theme are given below.

Something that only those who know how to fight can achieve:

- Mathematics is like climbing a steep mountain. When we encounter a problem in real life, we use mathematics. We collect and compare the data and make calculations with appropriate mathematical operations (Kılıç & Yanpar, 2013).

- Studying in the mathematics department pushed me a lot, I was very stressed, there were times when I gave up, but I was not motivated, and I was motivated again and again (GK16).

An action that requires strict and continuous work:

- Math is as difficult as preparing ravioli. It requires hard work like mathematics (Koca, 2010).
- Teaches patience in solving problems encountered in life (FK7).

With ups and downs:

- Mathematics is a bumpy process as it goes up and down a hill (Latteral & Wilson, 2017).
- Mathematics is like life itself, tasteless, sad, joyful, complex, exhausting (FE15).

People cannot avoid learning:

- Math is like a virus. When you take it to your body, it does not leave your body till untreated (Erdoğan et al., 2014).
- All exams in our country have mathematics (FE25).

Quick to do while doing:

- Math is like a plane. Because it is a discipline that requires speed, such as flying a plane (Koca, 2010).
- Having the knowledge of mathematics, such as rapid thinking, mind activity and speech (FK17).

The following are examples of the metaphor and connotation of categories of objective description.

A tool for life:

- For me, math is like a repair bag that I always carry with me. Because I can solve some questions I know with mathematical rules (Güner, 2013).
- Societies develop with steps that move the world forward, and this goes from mathematics (FE31).

Self-repeating applications:

- The types of mathematical problems with the same solution are similar to the same fish (Kılıç & Yanpar, 2013).
- Teacher candidates did not produce connotations in this category.

A figure with one correct answer:

- Math is similar to a labyrinth. When you enter, there is only one right way out (Erdoğan et al., 2014).
- Fills your life with clear and precise answers (FK7).

Contains unsolved problems:

- Math is like Aids. Both have many details that have not yet been discovered and can never be found (Erdoğan et al., 2014).
- In this category, teacher candidates did not produce connotations.

An important phenomenon that is both basic and helpful for other sciences:

- Math is like a lion. Lion, as the king of the forest, mathematics is the judge of other science fields (Erdogan et al., 2014).
- Many inventions and the basis of the invention are mathematics (GE22).

The examples of metaphor and connotation of emotion theme are given below.

Exciting, fun, easy, beautiful, enjoyable:

- Mathematics is like a puzzle that consists of many small pieces. When combined, a masterpiece emerges (Latteral & Wilson, 2017).
- My math adventure began in elementary school. Good day. 8. A new math teacher came in the classroom. I was happy, but I was so excited. He entered the class after introducing himself. There was a chalkboard back then. He put candies on a blackboard and wrote questions on the blackboard. He was going to give us a candy for every question we had. I had to solve those questions to get those candies. I made more ambitions and solved those questions. It tasted pretty good. So I began to love mathematics even more (GE19).

Difficult, boring, self-helpless, meaningless effort:

- The math is similar to walking in a minefield but I don't want to walk (Latteral & Wilson, 2017).
- It evokes numbers, problems, mixed questions, non-proof theorems (FK13).

## Discussion

Mathematics is one of the most important concepts in individuals' lives. Examining the metaphors or connotations produced by individuals towards mathematics provides an understanding of both the quality of their accumulated learning about mathematics and the quality of mathematics teaching.

The aim of this study is to examine the metaphors produced by the students of different school types who are the participants of eight different articles given by (Güveli et al., 2011; Erdoğan et al., 2014; Keleş et al., 2016; Koca, 2010; Schinck et al., 2008; Latterell and Wilson, 2017; Güner, 2013; Kılıç and Yanpar, 2013) from secondary school to university and to identify the categories that contain these metaphors and to find new themes that represent these categories. In addition, in 2015 and 2018, to determine the connotations produced by the mathematics teacher candidates in the formation certificate program about the concept of mathematics and these connotations are classified according themes and sub-categories created by the authors of this research.

This study is a qualitative research method prepared in a phenomenon (phenomenology) pattern. Phenomenology studies focus on the fundamental differences in how the phenomenon is experienced. With the help of researches in the phenomenology pattern, the relationship between the individual and what he / she is trying to learn is understood and explained. In this study, in Turkey's Aegean region has been conducted by the Faculty of Education at a state university mathematics teacher candidates who participated in the formation certificate programs in different years.

Both groups were given a questionnaire that included open-ended questions as well as individual information. The open ended questions are as follows: "What is your opinion about mathematics? What kind of connotation does it make you? Explain why? The collected data were analysed by content analysis method.

According to the findings of the study, the metaphors produced by participants with different school types and the themes and categories obtained from these metaphors were examined in the literature and it was seen that the categories could be classified under

Definition, Description and Emotion Themes. Considering the frequency of addressing the categories obtained from metaphors produced in mathematics concept in literature studies, it was seen that the categories that were emphasized intensely are a model trying to understand life and its contents, being an action that requires strict and steady work and a necessary tool for life. In addition, the categories that students with different types of schools emphasize in each theme are examined. The categories that come to the fore in the definition theme are a mental activity field with a model trying to understand life and its contents. In subjective description, they refer to the subcategory that only those who know how to fight can achieve. Subcategories, which are heavily emphasized in objective description, are a necessary tool for life and an important phenomenon that is both basic and helpful for other sciences. In the theme of emotion, students have produced positive connotations about the concept of mathematics, intensively.

In addition, the categories that one of the Turkish and foreign students participating in the researches such as primary school teacher, elementary school mathematics teacher and high school types were emphasized but the other did not. In this context, primary school teacher and elementary mathematics teachers' emphasis on almost every category shows that they have an intense knowledge about the concept of mathematics. It is thought that this accumulation of perception will be beneficial when preparing learning environments for mathematics lesson in the professional life of primary and elementary mathematics teacher candidates.

Moreover, primary school and pre-school teacher candidates as well as middle school students have both positive and negative attitudes about the concept of mathematics, while social studies teacher candidates and high school students have negative attitudes in selected studies from literature. Elementary mathematics teacher candidates emphasized positive attitudes only. The harmony between student's attitude towards mathematics and the type of score in university placement is remarkable. With the help of metaphors, students with negative attitudes about mathematics should be identified and necessary precautions should be taken.

The categories where foreign participants emphasize intensively and Turkish participants do not are with ups and downs (if primary school teachers candidates compared), only those who know how to fight can achieve (if elementary mathematics teachers candidates compared), a necessary tools for life (if high school students compared). The categories that Turkish participants emphasized intensively and foreign participants do not are a model trying to understand life and its contents (if primary school teachers candidates compared), An essential tool for life (if elementary mathematics teachers candidates compared), quick to do while doing, a necessary tools for life (if high school students compared). From these findings, it can be said that foreign primary school and elementary school mathematics teacher candidates and Turkish high school students have a more realistic perspective. In addition, the fact that Turkish high school students emphasize the category that quick to do while doing the concept of mathematics informs us about the quality of the measurement exams. A learning and teaching environment focused on finding the right answer in a short time does not reflect the true nature of mathematics teaching. Real-world applications should also be included in educational environments (Koca, 2010). Although the field is a defined category in the literature, the first of the two categories that are not known by the participants of the study is Self-repeating applications (Güveli et al., 2011) and the other is Contains unsolved problems (Kılıç & Yanpar, 2013).

In the second part of the study, the frequency of the connotations produced by the prospective mathematics teachers participating in the formation certificate program about the concept of mathematics and their categories were determined. In this context, teacher candidates emphasize that mathematics is a mental activity area. In addition, they emphasize mathematics as a necessary tool for life, the universe and the events we live in the current shopping relations. Besides, they think that dealing with mathematics is not the work of ordinary people and that they require struggle, and that they are separated from others in the society. Female participants of the research in 2018 produced 72.7% (8) of all connotations (11) produced in the exciting, fun, easy, beautiful, tasteful category. Male, on the other hand, did not produce a connotation in the category of meaningless effort that you felt difficult, boring, and helpless. Female and male teacher candidates participating in the research into category A figure with one correct answer in 2015 can be interpreted to be compatible with their study, the quality of the teaching they receive. Koca (2010) recommends that students who explain the correct or incorrect answers to mathematical questions with their black or white metaphor should include their teachers in their classroom activities, open-ended problems and projects that show that mathematics has gray areas other than black and white areas. When all connotation are examined, it can not be encountered any connotations such as web, internet, video games (Schink et al., 2008), computers and mobile phones. This situation can be interpreted as not using technological tools effectively in learning environments.

## References

- Çepni S. (2014). *Araştırma ve Proje Çalışmalarına Giriş*. (7. Baskı ). Trabzon: Celepler Matbaacılık.
- Erdogan A., Yazlık D. O., Erdik C. (2014). Mathematics teacher candidates' metaphors about the concept of mathematics. *International Journal of Education in Mathematics, Science and Technology*, 2(4), 289–299.
- Filiz S. B. (2018). Pedagojik formasyon öğrencilerinin matematik kavramına ilişkin metaforik algıları. *İnesjournal*, 5(15), 251-269.
- Güler G., Öçal M. F., Akgün L. (2011). Pre-service mathematics teachers' metaphors about mathematics teacher concept, *Procedia Social and Behavioral Sciences*, 15, 327–330.
- Güler G., Akgün L., Öçal M. F., Doruk M. (2012). Matematik öğretmeni adaylarının matematik kavramına ilişkin sahip oldukları metaforlar. *Eğitim ve Öğretim Araştırmaları Dergisi*. 1(2), 25-29.
- Güner N. (2012). Using metaphor analysis to explore high school students' attitudes towards learning mathematics. *Education*, 133, 39-48.
- Güner N. (2013). Öğretmen adaylarının matematik hakkında oluşturdukları metaforlar. *NWSA-Education Sciences*, 8(4), 428-440.
- Güveli E., İpek A. S., Atasoy E., Güveli H. (2011). Prospective primary teachers' metaphorical perceptions towards mathematics. *Turkish Journal of Computer and Mathematics Education*, 2(2), 140-159.
- Khait A. (2005). The definition of mathematics: philosophical and pedagogical aspects. *Science & Education*, 14(2), 137-159.
- Keleş O., Taş I., Aslan D. (2016). Metaphor perceptions of pre-service teachers towards mathematics and mathematics education in preschool education. *Educational Research and Reviews*, 11(14), 1338- 1343.
- Kılıç C., Yanpar T. Y. (2013). Belgian and Turkish pre-service primary school teachers' metaphoric expressions about mathematics. *Eğitim Araştırmaları-Eurasian Journal of Educational Research*, 50, 21-42.
- Koca, S. A. Ö. (2010). If mathematics were a color. *Ohio Journal of School Mathematics*, 62, 4-10.
- Latterell C., Wilson J. (2016). Math is like a lion hunting a sleeping gazelle: Preservice elementary teachers' metaphors of mathematics. *European Journal of Science and Mathematics Education*, 4(3), 283-292.
- Latterell C., Wilson J. (2017). Metaphors and mathematical identity: Math is like a tornado in Kansas. *Journal of Humanistic Mathematics*, 7(1), 46-61.
- Miles, M. B., Huberman, A. M. (1994). *Qualitative data analysis*. Thousand Oaks, CA: Sage
- Saban A., (2004). Giriş düzeyindeki sınıf öğretmeni adaylarının öğretmen kavramına ilişkin ileri sürdükleri metaforlar. *Türk Eğitim Bilimleri Dergisi*, 2(2), 131-155.



- Schinck A. G., Neale H. W., Pugalee D. K., Cifarelli V. V. (2008). Structures, journeys, and tools: Using metaphors to unpack student beliefs about mathematics. *School Science and Mathematics*, 594-599.
- Yob I. M. (2003). Thinking constructively with metaphors. *Studies in Philosophy and Education*, 22, 127-138.

## Genişletilmiş Özet

### Giriş

Matematik, bireylerin hayatında en çok anlam yüklediği kavramlardan biridir. Bireylerin matematiğe yönelik ürettikleri metafor ya da çağrışımları incelemek hem matematik hakkında birikmiş öğrenmelerinin niteliğini hem de yapılan matematik öğretiminin niteliğini anlamayı sağlar.

Bu çalışmanın amacı ortaokuldan üniversiteye literatürden seçilmiş sekiz ayrı makalenin katılımcılarını oluşturan farklı okul türüne sahip öğrencilerin matematik kavramı hakkında oluşturdukları metaforları incelemek ve bu metaforları içeren kategorileri belirlemek ve belirlenen kategorileri de temsil eden yeni temalar bulmaktır. Ayrıca 2015 ve 2018 yıllarında formasyon sertifika programında öğrenim gören matematik bölümü öğretmen adaylarının Matematik kavramı hakkında ürettiği çağrışımları belirlemek ve bu çağrışımları önceden belirlenen tema ve alt kategorilere göre sınıflandırmaktır.

### Yöntem

Bu çalışma Nitel araştırma yöntemlerinden olgubilim (phenonology) deseninde hazırlanmış bir çalışmadır. Olgubilim çalışmaları olgunun tecrübe edilme şekillerindeki temel farklılıklara odaklanır. Olgubilim deseninde yapılan araştırmalar yardımıyla bireyle anlamaya ya da öğrenmeye çalıştığı şey arasındaki ilişkiler anlaşılmaya ve açıklanmaya çalışılır.

### Katılımcılar

Bu çalışma, Türkiye'nin Ege Bölgesinde bir devlet üniversitesinin Eğitim Fakültesinde Formasyon Sertifika Programına Matematik Bölümünden katılan 2015 yılında 32, 2018 yılında 27 öğretmen adayı ile yapılmıştır. Her iki gruba da içinde bireysel bilgilerinin yanı sıra "Matematik hakkındaki düşünceniz nedir? Sizde ne gibi bir çağrışım uyandırıyor? Nedenini açıklayınız?" açık uçlu sorusunu içeren bir anket formu verilmiş, toplanan veriler içerik analizi yöntemiyle analiz edilmiştir.

### Bulgular, Sonuç ve Tartışma

Çalışmadan elde edilen bulgulara göre, farklı okul türüne sahip katılımcıların "matematik" kavramı hakkında oluşturdukları metaforlar ve bu metaforlardan elde edilen tema ve kategoriler alan yazında incelenmiş ve kategorilerin Tanım, Betimleme, Duygu Temaları altında sınıflandırılabilceği görülmüştür. Alan yazın çalışmalarında matematik kavramı hakkında üretilen metaforlardan elde edilen kategorilerin ele alınma sıklıkları göz önüne alındığında, Hayatı ve içindekileri anlamaya çalışan bir model, Sıkı ve sürekli bir çalışma gerektiren eylem, Yaşam için gerekli bir araç kategorilerinin yoğun olarak vurgulandığı anlaşılmıştır. Çalışmada ayrıca farklı okul türüne sahip öğrencilerin her bir temada yoğun vurgu yaptığı kategoriler incelenmiştir. Bunun yanı sıra Sınıf öğretmenliği, ilköğretim matematik öğretmenliği ve lise okul türlerinden araştırmalara katılan Türk ve yabancı öğrencilerin birinin yoğun vurgu yaptığı halde diğerinin hiç vurgu yapmadığı kategoriler de incelenmiştir. Bu bağlamda, Sınıf ve İlköğretim matematik öğretmen adaylarının hemen hemen her kategoriye vurgu yapmaları, matematik kavramı hakkında yoğun bir algı birikimine sahip olduklarını göstermektedir. Ayrıca, Türk lise öğrencilerinin matematik kavramı hakkında yaparken hızlı olunması gereken

kategorisine vurgu yapması da, yapılan ölçme sınavlarının niteliği hakkında bizi bilgilendirmektedir.

Çalışmanın ikinci kısmında Formasyon sertifika programına katılan matematik öğretmen adaylarının matematik kavramı hakkında ürettikleri çağrışımların sıklıkları ve ait oldukları kategoriler belirlenmiştir. Bu bağlamda çağrışım sıklığı yoğun olan kategorilerin, hayatı ve içindekileri anlamaya çalışan bir model, zihinsel bir faaliyet alanı, sadece mücadele etmeyi bilenlerin başarabileceği, yaşam için bir araç, diğer bilimler için hem temel hem yardımcı, hem olumlu hem de olumsuz tutum belirten kategoriler olduğu anlaşılmıştır. Çalışmada ayrıca her bir temaya ait kategorilerdeki çağrışımların sıklıkları hem cinsiyet hem yıl değişkenlerine göre incelenmiştir. Bu bağlamda, Kadın katılımcılar Erkek katılımcılara göre olumlu tutum belirten kategoride %72,7 daha fazla çağrışım üretmişlerdir. Erkek katılımcılar olumsuz tutum belirten kategoride hiçbir çağrışım üretmemişlerdir. Ayrıca, 2015 öğretmen adaylarının matematik hakkında, tek doğru cevaplı bir figür kategorisine vurgu yapması, öğrenme ortamlarında sadece tek doğru cevaba sahip sorularla yüzleştirildiklerini, proje çalışmalarına yeterince yer verilmediğini göstermektedir.