

Determining the Perceptions of Female Mathematics Teachers Concerning the Concept of “Female Mathematician” Through Metaphors^{*}

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Received: June 11, 2018

Accepted: July 6, 2018

Online Published: July 10, 2018

doi:10.11114/jets.v6i9.3342

URL: <https://doi.org/10.11114/jets.v6i9.3342>

Abstract

The aim of this study is to analyze the perceptions of female mathematics teachers concerning the concept of “female mathematician” through metaphors. In the study, phenomenology method was used. The participants consisted of 98 female mathematics teachers who work at secondary schools. The data was obtained through the statement “Female mathematicians are like ... because ...” completed by female mathematics teachers. The teachers were asked to write a metaphor in the first blank concerning the concept of female mathematician and they wrote their reasons of writing that metaphor in the second blank. The data was analyzed through content analysis method. At the end of the study, it was determined that the teachers had formed 71 different metaphors concerning female mathematicians. The first three concepts occurring to the minds of mathematics teachers concerning the concept of female mathematician were found as “male mathematician”, “mother” and “equation”. Additionally, it was determined that the metaphors of the teachers were collected under six different categories. Among these categories, the category of “female mathematician as a person who has desired qualities and is needed” was observed to be emphasized more distinctly. It was also seen that explanations of the teachers were collected under 34 features and among these features; the codes of “scarcity” and “incomprehensibility” were emphasized more distinctly. Finally, it was determined that metaphors, categories and features concerning female mathematicians had a positive meaning in general. It is recommended to enhance the living and working conditions of female mathematics teachers and increase their number.

Keywords: mathematics teachers, female mathematicians, metaphors, phenomenology, perception

1. Introduction

It is a common fact that men do not have a monopoly on science that makes life easier and enables us to understand the universe (Naymansoy, 2009). When the history of science examined, it can be seen that women also make great contributions to the process of producing knowledge and are included in many precious studies (Swetz, 1994; Yildiz, & Hacisalihoglu-Karadeniz, 2017). The idea that women have nothing to tell has continued throughout history (Zengin, 2017). As a consequence, collocation of the terms “science” and “woman” has been found odd by some communities for a long time (Naymansoy, 2010). This condition has caused women to take on important roles and responsibilities mainly in family and household management (Kaygisiz, 2018). In addition, since mathematics used to be introduced as a terrifying discipline for women and considered a man thing, it had continued its existence only as “the world of men” (Kumcu, 2005). Despite all these limitations, restrictions and role selections, women have never abstained from forcing the doors of the science world (Fidan-Kocak, Taskin, & Ozpinar, 2010). Today, it is possible to state that mathematics is one of the areas where women try to do science actively just like in many other disciplines. It has been possible for women to reach this level in mathematics as a result of a struggle of years that have been underestimated and excluded from scientific studies for thousands of years (Kumcu, 2004).

One of the main factors is education giving the impression that men are more successful and talented in learning mathematics than women (Tang, Chen, & Zhang, 2010). On the other hand, developments and changes in education and innovations based on social gender equality have changed the role of women in mathematics in recent years (Fidan-Kocak & Isik, 2009). Thus, women have had the chance to work with men in mathematics researches. Recently, there has been a gradual increase in the

^{*}This study is an expanded version of that verbally presented in the “Second National Symposium on Women” (2018, Giresun, TURKEY).

presence and number of women in the area of mathematics (Unverdi & Unverdi, 2010). Even though “Female Mathematicians (FM)” who like and interested in mathematics faces with many obstacles that they have made contributions to mathematics with many researches and studies using their mathematician identity and proven their presence in this area. Thus, mathematics has become a way of understanding and loving the life for FMs (Fidan-Kocak et al., 2010).

Teachers are undeniably responsible for forming the democratic structure in society, providing peace, raising socialized individuals and handing the national values of society down the next generations (Celikten & Can, 2003). It is possible to state that female mathematics teachers, in other words FMs have a special position in fulfilling these responsibilities. Female mathematics teachers are always considered as important and necessary beings because they are one of the important elements of education. There is a need for detailed and clear information about how female mathematics teachers that are role models in raising students explain and define the concept of “FM”. Because determining the perceptions of female mathematics teachers who observe students and evaluate their development concerning FMs due to their mission of setting an example especially for girls and preparing them to life will provide a reference to researchers who will conduct relevant studies. In addition, the present study is important in terms of not only introducing the perceptions of female mathematics teachers concerning FMs into the literature, but also making it possible to create new perspectives on women’s visibility. Revealing the perceptions of female mathematics teachers who are an important part of society and play an important role in education concerning FMs is also necessary for affecting the society and directing education. Additionally, it is believed that the study will not only increase the number of FMs and make other people understand them better, but also provide useful information to the literature.

It is believed that metaphors are one of the ways of understanding how female mathematics teachers establish their perceptions about FMs and how they perceive FMs. Metaphors are used as an important means of revealing perceptions and attitudes in explaining concepts like school, classroom, student, teacher that are included in educational environments (Aydin & Pehlivan, 2010). Thus, metaphors are used for revealing the perceptions of female mathematics teachers within the scope of this study concerning the concept of “FM”.

Individuals can build their own reality by means of metaphors and metaphorically (Lakoff & Johnson, 2015). Therefore, metaphors are one of the ways for individuals to express themselves and establish relationships (Sengul, Katranci, & Gerez-Cantimer, 2014). Metaphors lead real perceptions and interpretations (Lopez, 2007). Thus, metaphors are frequently used as an important means in education (Dos, 2010). The term metaphor is defined as “mecaz” by the Turkish Language Association (TLA, 2011) and used as “simulation”, “borrowing” and “figure of speech” in the literature (Demirtas & Coban, 2014). The term also has many other definitions. For example, Aristotle (2008) expressed metaphor as “giving another meaning to a word outside of its specific meaning”. Lakoff and Johnson (2015), on the other hand, defined metaphor as a means of understanding a phenomenon according to another phenomenon and helping people to perceive the world. Metaphors are mental maps that enable us to understand complex opinions more easily (Arslan & Bayrakci, 2006). In other words, metaphors are strong mental instruments that direct and structure opinions regarding the formation and progression of events (Soysal & Afacan, 2012).

Metaphors connect people’s imagination and experience areas (Demirtas & Coban, 2014). Therefore, metaphors can reveal perceptions (Zhao, Coombs, & Zhou, 2010). In the literature, there are limited numbers of studies revealing the perceptions concerning the female metaphor. Sozer and Ozkan (2014) determined 49 metaphors formed by pre-service social studies teachers for the phenomenon of “woman” which are collected under six categories as “living being”, “authority”, “nature”, “object”, “characterization” and “abstract”. Basarir and Sari (2015) also determined that female academicians explained the concept of “being a female academician” with 65 metaphors and these metaphors were collected under nine different categories. These categories define a female academician as a “miraculous being” and “housewife” who; “have multiple tasks and responsibilities”, “contribute to other people with their productions”, “work hard”, “stay strong against to difficulties”, “make self-sacrifice”, “have to redress the balance”, and “have no name”. Ozkan (2017) determined that pre-service teachers at faculties of education explained the concept of “woman” with 234 different metaphors. In addition, these metaphors were collected by the researcher under six categories as “living being”, “nature”, “authority”, “object”, “characterization” and “abstract”.

According to literature, there are metaphor studies on the concepts of “woman” and “being a female academician”, whereas there is no study intended to determine the metaphoric perceptions of female mathematics teachers concerning the concept of “FM”. In addition, it is believed that the present study will draw attention to the importance of the concept of “FM” and fill the gap in the literature. It is also believed that the study will make important contributions to other studies on FMs and metaphor studies. Thus, investigating the metaphors of female mathematics teachers concerning FMs is very important for revealing the whole picture. In this context, the study aims to reveal the perceptions of female mathematics teachers concerning the concept of “FM” by means of metaphors. Within the frame of this aim, the following questions are tried to be answered:

1. What are the metaphors expressed by female mathematics teachers concerning the concept of “FM”?
2. What are the first three concepts occurring in the minds of female mathematics teachers concerning the concept of “FM”?
3. Under which categories are the metaphors of female mathematics teachers gathered concerning the concept of “FM”?
4. Under which features are the explanations of female mathematics teachers gathered concerning the concept of “FM”?

2. Method

This study is a qualitative study using phenomenology method. Phenomenology is concerned with how individuals understand, explain, remember and evaluate a phenomenon and how they convey it to other people (Patton, 2002). In other words, phenomenology method focuses on personal experiences of individuals (Cekmez, Yildiz, & Butuner, 2012). Additionally, events and perceptions are revealed integrative and realistically in their natural environment through this method (Yildirim & Simsek, 2006). In the present study, the common meanings attributed to the concept of “FM” by female mathematics teachers were determined through metaphors using phenomenology method.

2.1 Study Group

The participants were determined by considering the study objective and using purposeful sampling method. In this context, the participants consisted of female mathematics teachers. The study was conducted with a total of 98 female mathematics teachers working at secondary schools in seven different provinces during the fall term of the school year of 2017-2018. The teachers participated in the study voluntarily. Table 1 shows information about the participants’ ages, years of work experience and institutes/faculties of graduation:

Table 1. Some demographic characteristics of female mathematics teachers

Characteristics	Categories	<i>f</i>	%
Age	20-25	21	21.4
	26-30	17	17.3
	31-35	26	26.5
	36 and older	34	34.7
Year of Work Experience	0-5	10	10.2
	6-10	19	19.4
	11-15	31	31.6
	16-20	18	18.4
	21 and older	20	20.4
Institute/faculty of Graduation	Three-year training institute	8	8.2
	Faculty of education	57	58.2
	Faculty of arts and sciences	33	33.7

When the Table 1 examined, it can be seen that majority of female teachers are middle-aged, experienced and had graduated from faculties of education.

2.2 Development and Application of Data Collection Tool

A two-stage form was used to determine the metaphoric perceptions of female mathematics teachers concerning the concept of “FM”. The first stage of the form includes three questions about the teachers’ ages, years of work experience and institutes/faculties of graduation. The second stage of the form includes a two-part question about the concept of “FM”. The first part of the question includes the statement, “*Female mathematicians are like ...*” in order to determine the metaphor associated by female teachers with FMs. The second part of the question includes a section that begins with “*because ...*” in order for the teachers to explain the metaphor associated with FMs. As indicated by Forceville (2002), this question about the concept of “FM” contains three elements:

1. Subject of metaphor (The word “FM” in the statement, “FMs are like boron mine.”)
2. Source of metaphor (The concept of “boron mine” in the statement, “FMs are like boron mine.”)
3. Features attributed from the source of metaphor to the subject of metaphor (The word “precious” in the statement, “FMs are like boron mine because they are precious.”)

This question which was prepared examining the studies by Erickson and Pinnegar (2017), Ma and Gao (2017), Shaw and Mahlios (2011), Vickery (2018), was presented to two field experts for their opinions. The question was arranged according to the opinions of the field experts. Then a pilot pilot implementation was conducted with 30 female mathematics teachers who were selected randomly before the main implementation. The question was reviewed with the pilot implementation and the time to be given to the teachers in the main implementation was determined. In the main implementation, the teachers who participated in the study were informed about the study objective and how to fill out the data collection tool and then they were asked to answer the question. The teachers were asked to write a metaphor in the

first part of the blank and an explanation about the metaphor in the second part. They formed metaphors concerning the concept of “FM” within 15 minutes and explained them in detail. Final form of the data collection tool is in the attachment.

2.3 Data Analysis

The studies related to metaphors in the literature (Beldag & Gecit, 2017; Deringol & Gulden, 2016; Ma & Gao, 2017; Vickery, 2018) were reviewed before analyzing the data. As a result of review, it was decided to analyze the data step by step for the purpose of revealing the data analysis process in detail and guide researchers who would conduct a metaphor analysis for the first time. Thus, the data analysis was completed in five stages. Following are some detailed information about these stages:

1. Stage of Denomination: In this stage, all the statements of female mathematics teachers concerning the concept of “FM” were transferred to an Excel table. During the process of transferring, some incoherent statements of the teachers were corrected in a way that their meaning would remain the same. Then it was tried to determine how many different metaphors were formed by the teachers. In this process, it was determined that each teacher had developed a metaphor, but some of the metaphors had been formed by more than one teacher. Thus, a list consisting of 71 metaphors was formed. Finally, the metaphors formed by the teachers were defined as concepts.

2. Stage of Elimination: In this stage, the statements written by the teachers were read and it was tried to determine whether the participants expressed the metaphors distinctly or not. In this context, the metaphors were reviewed in terms of the “subject of metaphor”, “source of metaphor” and “features between the subject and source of metaphor”. Accordingly, the data that was not suitable for the study objective were eliminated. Six forms were excluded from the analysis due to irrelevant association. Thus, it was decided to analyze 92 forms.

3. Stage of Forming Codes, Categories and Features: In this stage, content analysis method was used. This method enables us to form a certain frame after interpreting the raw data and develop codes and categories after clarifying the situation (Patton, 2002). The answers given by the teachers to the first and second part of the open-ended question in the data collection form were put under the titles of “source of metaphor” and “features between the subject and source of metaphor”. Then the statements of the participants beginning with “because” were coded considering what features of the concept of “FM” had been used by the participants to develop metaphors. While coding, words or word groups reflecting the explanations of the teachers were determined in the best way and the 60 codes were formed in total. Relevant codes were brought together and six categories were developed following the process of coding. Finally, some codes were taken exactly, some were combined and thus, 34 features were formed concerning the concept of “FM”. In the TLA (2011), feature is defined as “a quality separating something from equivalents or other things”. Sentences formed by combining relevant codes are called feature considering this definition by the TLA. Because the teachers explained some metaphors in a way that they could be included in several categories at the same time, such metaphors were included under multiple categories. Table 2 shows an example to how the coding process is done and how the features are formed:

Table 2. Coding the statements of female mathematics teachers

Source of Metaphor	Features between the Subject and Source of Metaphor	Coding	Feature
Chef	...because ... is attentive and careful...	- FMs are attentive. - FMs are careful.	FMs are attentive (<i>f</i> : 1), careful (<i>f</i> : 1) and sensitive (<i>f</i> : 1).
A Journey to Hope	...because learning and teaching process of mathematics is too hard... Female teachers are more sensitive in this respect...	- FMs are sensitive.	

4. Stage of Providing Validity and Reliability: Reporting the data in detail and indicating how the researcher has attained the results are among the important criteria of validity in qualitative studies (Yildirim & Simsek, 2006). Thus, the concept of “FM”, participants, data collection and analysis process were explained in detail in order to provide validity in the study. In addition, statements of the teachers about the features being formed were included without any interpretations. In the situations which have long sentences, some words or sentences were removed through keeping the meaning. Triple dots (...) were used instead of these removed words or sentences. The codes formed by the researcher were presented to a field expert and their compatibility was examined in order to provide reliability in the study. Numbers of consensus and dissensus were determined and consistency of the codes formed by the researcher and the field expert was settled while comparing the codes. Coding reliability was calculated as 91% by using the formula of Miles and Huberman (1994) [Reliability = Consensus / (Consensus + Dissensus) x 100]. Then the researcher subjected the codes to a preliminary grading and formed temporary eight categories based on the relationship of the codes with each other. Categories are formed using participants, researchers, field experts and the literature (Arik & Benli-Ozdemir, 2016). In this study, the categories were formed through the literature, researchers and field experts. In this context, the categories

were presented to a field expert for his opinions who is a mathematics trainer. As a result of sharing opinions with the field expert, the categories of “FM as a mysterious person”, “FM as a complex person”, “FM as a person paying attention to personal differences” and “FM as a motivating and self-sacrificing person” were combined. The combination was made mainly because the categories were interrelated and the categories of “FM as a mysterious person” and “FM as a motivating and self-sacrificing person” had fewer frequencies. By this way, the number of categories was reduced to six. The categories were finalized according to the recommendations of the field expert, experiences of the researcher and studies in the literature and the categories are presented in Table 4. This classification was presented to a qualitative research expert for a review and its reliability was calculated. Reliability values between the researcher and qualitative research expert was found as 90% for the codes under the first category, 92% for the codes under the second category, 94% for the codes under the third category, 95% for the codes under the fourth category, 96% for the codes under the fifth category and 98% for the codes under the sixth category. The acceptable reliability was stated by the formula of Miles and Huberman (1994) as greater than 70% and Saban (2009) greater than 90% which they accepted to be reliable for studies. Finally, the researcher and qualitative research expert discussed about the codes on no consensus was built. As a result of that discussion, a consensus was built on the codes and the categories where the codes would be included.

5. Stage of Arranging the Data to Calculate Frequency and Percentage Values: Frequencies of features (f) and frequencies (f) and percentages (%) of metaphors and categories were calculated after metaphors were determined and the codes and categories were formed. Features were presented as direct statements, whereas categories and metaphors were displayed in tables.

3. Results

Table 3 shows 71 metaphors expressed by female mathematics teachers concerning the concept of “FM”:

Table 3. All metaphors formed by the teachers concerning the concept of “FM”

Metaphors	f	%	Metaphors	f	%	Metaphors	f	%
1. Male mathematician	5	5.4	25. Water	1	1.1	49. Pool problems	1	1.1
2. Mother	4	4.3	26. Food	1	1.1	50. Brilliant	1	1.1
3. Equation	4	4.3	27. Swan	1	1.1	51. Real number	1	1.1
4. Infinity	3	3.3	28. Pale rose	1	1.1	52. Ray	1	1.1
5. Ivy	2	2.2	29. Adverse tulip	1	1.1	53. Whole number	1	1.1
6. Origin	2	2.2	30. Black sea rain	1	1.1	54. Zero on the right of a number	1	1.1
7. Number x	2	2.2	31. Wind	1	1.1	55. Coffee	1	1.1
8. Snowdrop	2	2.2	32. Light	1	1.1	56. Difference cluster	1	1.1
9. Boron mine	2	2.2	33. Endemic plant	1	1.1	57. Rational number	1	1.1
10. Diamond	2	2.2	34. Sun	1	1.1	58. Starting point on a numerical axis	1	1.1
11. Scientist	2	2.2	35. Ghost orchid	1	1.1	59. Zero	1	1.1
12. Chef	2	2.2	36. Rainbow	1	1.1	60. Largest prime number	1	1.1
13. Algebraic expression	2	2.2	37. Star	1	1.1	61. X within an absolute value	1	1.1
14. Gold	1	1.1	38. House column	1	1.1	62. Center of a circle	1	1.1
15. Effect of golden proportion on a painting	1	1.1	39. Chess player	1	1.1	63. Perpendicular bisector	1	1.1
16. Song	1	1.1	40. Love	1	1.1	64. Square	1	1.1
17. Poem	1	1.1	41. Bow	1	1.1	65. Natural number	1	1.1
18. Leonardo Da Vinci	1	1.1	42. Life buoy	1	1.1	66. A difficult mathematics question	1	1.1
19. Truck driver	1	1.1	43. Danger	1	1.1	67. Pi	1	1.1
20. Love	1	1.1	44. Reality	1	1.1	68. Honey	1	1.1
21. Conquerer	1	1.1	45. Hour	1	1.1	69. Pizza with plenty of ingredients	1	1.1
22. Leader	1	1.1	46. A journey to hope	1	1.1	70. Wine	1	1.1
23. Artist	1	1.1	47. Looking for a needle in a haystack	1	1.1	71. Oil	1	1.1
24. Lawyer	1	1.1	48. Salt	1	1.1	Total	92	100

In Table 3, it is seen that the first three concepts occurring in the minds of female mathematics teachers concerning the concept of “FM” are “male mathematician”, “mother” and “equation”.

Six categories were developed examining the statements of female mathematics teachers concerning the concept of “FM”. These categories were arranged according to the numbers and percentages of participants indicating the metaphors and displayed in Table 4:

Table 4. Categories developed for FM

Categories	<i>f</i>	%
1.FM as a person who has desired qualities and is needed	24	26.1
2.FM as a strong and rare person who is eager to work	23	25.0
3.FM as a mysterious and complex person	16	17.4
4.FM as a person with multiple roles	12	13.0
5.FM as an instructive person	11	12.0
6.FM as a motivating and self-sacrificing person who pays attention to personal differences	9	9.8

In Table 4, it is seen that the category of “FM as a person who has desired qualities and is needed” comes into prominence.

Table 5 shows 23 metaphors under first category (FM as a person who has desired qualities and is needed) and the numbers of participants forming these metaphors:

Table 5. Metaphors under the category of “FM as a person who has desired qualities and is needed”

Metaphors	<i>f</i>	%
1.Algebraic expression	2	2.2
2.Chef	1	1.1
3.Wine	1	1.1
4.Effect of golden proportion on a painting	1	1.1
5.Salt	1	1.1
6.House column	1	1.1
7.Chess player	1	1.1
8.Leader	1	1.1
9.Swan	1	1.1
10.Poem	1	1.1
11.Zero on the right of a number	1	1.1
12.Scientist	1	1.1
13.A journey to hope	1	1.1
14.Boron mine	1	1.1
15.Brilliant	1	1.1
16.Reality	1	1.1
17.Square	1	1.1
18.Rational number	1	1.1
19.Pizza with plenty of ingredients	1	1.1
20.Song	1	1.1
21.Natural number	1	1.1
22.Equation	1	1.1
23.Rainbow	1	1.1
Total	24	26.1

In Table 5, it is seen that teachers generally compare FMs to the metaphor of “algebraic expression” in this category. Nine features of metaphors constituting the category of “FM as a person who has desired qualities and is needed” and quotations about these features are summarized in below:

Feature 1

FMs are precious (*f*: 3) and add value to people (*f*: 2).

“FMs are like swans because they are precious.”

“FMs are like zero on the right of a number because they can remain on the left; I mean the heart and add value to anyone who is able to keep them on the right.”

Feature 2

FMs are irreplaceable (*f*: 3), sweet (*f*: 1) and coherent (*f*: 1).

“FMs are like an equation because you may reject them at the beginning of learning, but then you cannot quit.”

“FMs are like wine because they are elegant and sweet.”

“FMs are like natural numbers because they are referred to whole numbers or rational numbers, when it is necessary and they are even encountered as repeating numbers and square roots. They are really compatible with eyes.”

Feature 3

FMs are elegant (*f*: 2), esthetical (*f*: 1) and pretty (*f*: 1).

“FMs are like a poem because they are elegant beings...”

“FMs are like the effect of golden proportion on a painting because it is necessary for them to be esthetical and pretty.”

Feature 4

FMs are smart (*f*: 2), logical (*f*: 1) and realistic (*f*: 1).

“FMs are like leaders because they are smarter...”

“FMs are like rational numbers because they are logical.”

“FMs are like reality because women are realistic.”

Feature 5

FMs are attentive (*f*: 1), careful (*f*: 1) and sensitive (*f*: 1).

“FMs are like chefs because ... they are attentive and careful...”

“FMs are like a journey to hope because mathematics has a really difficult process of learning and teaching and male teachers will not be as patient as female teachers. Female teachers are more sensitive in this respect...”

Feature 6

FMs are fun (*f*: 1), colourful (*f*: 1) and loving (*f*: 1).

“FMs are like a song because they are fun...”

“FMs are like a rainbow because they are so colourful...”

“FMs are like a poem because ... they are full of love.”

Feature 7

FMs are practical (*f*: 1), active (*f*: 1) and frank (*f*: 1).

“FMs are like an algebraic expression because instead of writing long sentences like ‘Which number makes 16 when multiplied with 3 and subtracted 5?’ they make it easier for us by expressing as $3x-5=16$. In other words, FMs are practical.”

“FMs are like a song because ... they are active.”

“FMs are like a square because they are frank, both inside and outside.”

Feature 8

FMs know how to live life to the fullest (*f*: 1).

“FMs are like leaders because ... they know how to live better.”

Feature 9

FMs plan life and put it in a certain order (*f*: 1).

“FMs are like scientists because they plan life and put it in a certain order.”

Table 6 shows 18 metaphors under second category (FM as a strong and rare person who is eager to work) and the numbers of participants forming these metaphors:

Table 6. Metaphors under the category of “FM as a strong and rare person who is eager to work”

Metaphors	<i>f</i>	%
1.Male mathematician	4	4.3
2.Diamond	2	2.2
3.Snowdrop	2	2.2
4.Love	1	1.1
5.Conquerer	1	1.1
6.X within an absolute value	1	1.1
7.Adverse tulip	1	1.1
8.Honey	1	1.1
9.Water	1	1.1
10.Infinity	1	1.1
11.Pi	1	1.1
12.Leonardo Da Vinci	1	1.1
13.Lawyer	1	1.1
14.Boron mine	1	1.1
15.Endemic plant	1	1.1
16.Gold	1	1.1
17.Looking for a needle in a haystack	1	1.1
18.Ghost orchid	1	1.1
Total	23	25.0

In Table 6, it is seen that the most frequently used metaphor is “male mathematician”, which is followed by the metaphors of “diamond” and “snowdrop”, each formed by two participants. Six features of metaphors constituting the category of “FM as a strong and rare person who is eager to work” and quotations about these features are summarized as follows:

Feature 1

FMs are rare (f : 10).

“FMs are like a diamond because they are rarely found in nature.”

Feature 2

FMs deal with mathematics (f : 3) and conquer mathematics (f : 1).

“FMs are like male mathematicians because they deal with mathematics just like male mathematicians.”

“FMs are like conquerors because they have conquered mathematics.”

Feature 3

FMs are never satisfied in their work (f : 3) and they destroy negativities with positive thinking (f : 1).

“FMs are like infinity because they are never really satisfied.”

“FMs are like an x within an absolute value because they destroy negativities with positive thinking.”

Feature 4

FMs need to struggle with difficulties (f : 1) and prove themselves in mathematics (f : 1).

“FMs are like a snowdrop because snowdrops can split the snow and meet the sun in wintertime when all other flowers are dead.”

“FMs are like a snowdrop because they have to prove themselves in an area where men have a greater number.”

Feature 5

FMs demand absolute results (f : 1) and try to make everyone believe in what they believe to be true (f : 1).

“FMs are like water because they are clear just like mathematics and demand absolute results.”

“FMs are like lawyers because they can make everyone believe that they know their duty accurately.”

Feature 6

Mathematics causes FMs to lose their hair (f : 1).

“FMs are like male mathematicians because mathematics causes both genders to lose their hair.”

Table 7 shows 11 metaphors under third category (FM as a mysterious and complex person) and the numbers of participants forming these metaphors:

Table 7. Metaphors under the category of “FM as a mysterious and complex person”

Metaphors	f	%
1.Equation	3	3.3
2.Number x	2	2.2
3.Ivy	2	2.2
4.Infinity	2	2.2
5.A difficult mathematics question	1	1.1
6.Male mathematician	1	1.1
7.Wind	1	1.1
8.Bow	1	1.1
9.Danger	1	1.1
10.Pool problems	1	1.1
11.Largest prime number	1	1.1
Total	16	17.4

In Table 7, it is seen that teachers generally compare FMs to the metaphor of “equation” in this category. Four features of metaphors constituting the category of “FM as a mysterious and complex person” and quotations about these features are summarized as follows:

Feature 1

FMs are incomprehensible (f : 10).

“FMs are like an equation because they can never be solved.”

Feature 2

FMs can get mad in an instant (*f*: 4).

“FMs are like the wind because they storm around in an instant and then continue as if nothing happened.”

Feature 3

FMs can approach to events from many perspectives (*f*: 1).

“FMs are like infinity because they have various viewpoints.”

Feature 4

FMs are full of mysteries (*f*: 1).

“FMs are like the largest prime number because they are full of mystery.”

Table 8 shows 11 metaphors under fourth category (FM as a person with multiple roles) and the numbers of participants forming these metaphors:

Table 8. Metaphors under the category of “FM as a person with multiple roles”

Metaphors	<i>f</i>	%
1.Origin	2	2.2
2.Difference cluster	1	1.1
3.Houri	1	1.1
4.Black sea rain	1	1.1
5.Real number	1	1.1
6.Starting point on a numerical axis	1	1.1
7.Truck driver	1	1.1
8.Zero	1	1.1
9.Scientist	1	1.1
10.Chef	1	1.1
11.Chess player	1	1.1
Total	12	13.0

In Table 8, it is seen that the metaphor of “origin” comes into prominence in this category. Five features of metaphors constituting the category of “FM as a person with multiple roles” and quotations about these features are summarized as follows:

Feature 1

Everything is beautiful with FMs (*f*: 2) and finds a meaning with them (*f*: 1).

“FMs are like houris because everything is beautiful with them.”

“FMs are like the starting point on a numerical axis because everything finds a meaning with them.”

Feature 2

FMs work like scientists (*f*: 1) and have different qualities (*f*: 2).

“FMs are like scientists because they work like them.”

“FMs are like a difference cluster because they have qualities that others don't.”

Feature 3

FMs are elaborative (*f*: 2) and contain everything within themselves (*f*: 1).

“FMs are like chefs because they are elaborative, attentive and careful...”

“FMs are like real numbers because they contain everything within themselves.”

Feature 4

FMs are at the centre of everything (*f*: 2).

“FMs are like an origin because they are at the centre of everything due to their gender and branch.”

Feature 5

FMs will react according to how you wish them to have an effect in your life (*f*: 1).

“FMs are like zero because they will react according to how you wish them to have an effect in your life.”

Table 9 shows nine metaphors under fifth category (FM as an instructive person) and the numbers of participants forming these metaphors:

Table 9. Metaphors under the category of “FM as an instructive person”

Metaphors	<i>f</i>	%
1.Mother	3	3.3
2.A journey to hope	1	1.1
3.Light	1	1.1
4.Food	1	1.1
5.Oil	1	1.1
6.Center of a circle	1	1.1
7.Coffee	1	1.1
8.Sun	1	1.1
9.Star	1	1.1
Total	11	12.0

In Table 9, it is seen that the metaphor of “mother” comes into prominence in this category. Four features of metaphors constituting this category and quotations about these features are summarized as follows:

Feature 1

FMs teach with patience (*f*: 4), love (*f*: 1) and compassion (*f*: 1).

“FMs are like mothers because they teach mathematics with patience, love and compassion.”

Feature 2

FMs cover up students’ deficiencies (*f*: 2).

“FMs are like oil because oils step in carbohydrate deficiency and always fill the deficiencies.”

Feature 3

FMs spread knowledge (*f*: 1) and keep the mind awake (*f*: 1).

“FMs are like light because just like all other mathematicians, they want to enlighten our children.”

“FMs are like coffee because they keep the mind awake.”

Feature 4

FMs treat students equally (*f*: 1) and want to reach all students (*f*: 1).

“FMs are like the centre of a circle because they have an equal distance to all students and treat them equally.”

“FMs are like the sun because they want to reach all students with the illuminating energy of mathematics.”

Table 10 shows the metaphors under sixth category (FM as a motivating and self-sacrificing person who pays attention to personal differences) and the numbers of participants forming these metaphors:

Table 10. Metaphors under the category of “FM as a motivating and self-sacrificing person who pays attention to personal differences”

Metaphors	<i>f</i>	%
1.Whole number	1	1.1
2.Ray	1	1.1
3.Chef	1	1.1
4.Perpendicular bisector	1	1.1
5.Mother	1	1.1
6.Life buoy	1	1.1
7.Pale rose	1	1.1
8.Artist	1	1.1
9.Love	1	1.1
Total	9	9.8

In Table 10, it is seen that teachers do not focus on a certain concept in this category and they all draw an analogy to a different concept. Six features of metaphors constituting this category and quotations about these features are summarized as follows:

Feature 1

FMs dedicate themselves to their job (*f*: 1) and provide infinity to individuals (*f*: 2).

“FMs are like a pale rose because they dedicate themselves to numbers, problems, and children in brief, to their job.”

“FMs are like whole numbers because they keep both minus infinite and plus infinite alive.”

Feature 2

FMs know the heart, eagerness and sensitivity of students (*f*: 1) and help them according to their needs (*f*: 1).

“FMs are like mothers because they know the heart, eagerness and sensitivity of students just like God.”

“FMs are like a life buoy because they help when needed...”

Feature 3

FMs introduce an esthetical dimension into mathematics ($f: 1$).

“FMs are like artists because they depict mathematics using the numbers openly. They introduce an esthetical dimension into a network system entwisted with numbers, in other words mathematics.”

Feature 4

FMs offer little treats to students ($f: 1$).

“FMs are like chefs because they offer little treats to students.”

Feature 5

FMs have an equal distance to adverse opinions ($f: 1$).

“FMs are like a perpendicular bisector because they have an equal distance to adverse opinions.”

Feature 6

FMs are appreciated only by those who like them ($f: 1$).

“FMs are like love because they are only appreciated by those who love them.”

4. Discussion, Conclusion and Recommendations

In this study intending to reveal the perceptions of female mathematics teachers concerning the concept of “FM” determined through metaphors and groups these metaphors under certain categories and features. Findings were discussed with the literature and the following results were attained:

It was seen that there was a need for many metaphors to explain the concept of “FM” as a whole. In the study, it was determined that female mathematics teachers formed 71 different metaphors concerning the concept of “FM”, which shows that the concept of “FM” cannot be explained with only one metaphor. Similarly, Sozer and Ozkan (2014) determined that pre-service social studies teachers explained the phenomenon of “woman” with 49 different metaphors, Basarir and Sari (2015) determined that female academicians explained the concept of “being a female academician” with 65 different metaphors and Ozkan (2017) determined that students at faculties of education explained the concept of “woman” with 234 different metaphors. In addition, the metaphors specified by the teachers also reveal their awareness about FMs. Teachers’ own perceptions and awareness about their reasons can be increased by using metaphors.

While the metaphors examined formed by female mathematics teachers concerning the concept of “FM”, it is seen that they generally prefer the metaphors of “male mathematician”, “mother” and “equation”. Female mathematics teachers indicate that they deal with mathematics and can perform mathematics just like male mathematics teachers. Thus, there is no way for male mathematicians to be superior to FMs. On the other hand, the prejudice offering that “mathematics is not meant for women” has dominated some communities for centuries and mathematics has been considered a man thing (Li, 2001; Tang et al., 2010). In other words, thoughts like “women should become mannish because attributions of science are mannish” have obstructed women’s presence in science (Nalbantoglu, 1997). It is believed that these thoughts had affected the participants to compare FMs to male mathematicians. The teachers stated that their knowledge gained favour to their students. Teachers’ utilization of their experiences for the benefit of their students instead of their own benefits can be explained with the role of “mother”. As a matter of fact, in the literature, it is seen that women are also identified with the role of motherhood (Alacadagli, 2018). Besides, as the participants believed that women were incomprehensible, they compared FMs to an equation. Thus, it is possible to state that metaphors can be used as an important means of understanding and explaining the perceptions of female mathematics teachers concerning the concept of “FM”.

There is also an obvious need for many categories to explain the concept of “FM”. In the study, it was seen that the metaphors formed by female mathematics teachers concerning the concept of “FM” were collected under six different categories, which shows that the perceptions of teachers concerning the concept of “FM” are multi-pronged and different. Similarly, Sozer and Ozkan (2014) and Ozkan (2017) grouped the metaphors of pre-service teachers concerning the phenomenon of “woman” under six categories. Basarir and Sari (2015), on the other hand, explained the metaphors of female academicians concerning the concept of “being a female academician” under nine categories. While the categories examined, it was concluded that teachers generally had a positive viewpoint of the concept of “FM”. These categories that were formed within the scope of the study can be used in scales to be developed for FMs. In addition, it is recommended for academicians in faculties of education to consider these categories while training female pre-service mathematics teachers.

While the categories examined which are formed concerning the concept of “FM” in the present study; it is seen that the category with the highest number of metaphors is “*FM as a person who has desired qualities and is needed*”. There is always a need for well-trained teachers in the educational process. Because teachers play a role in developing and changing educational environments as they not only enable individuals to grow as members of society, but also shape society (Sengul et al., 2014), which causes them to be considered as people who have desired qualities and are needed. It is recommended to give priority to women while admitting pre-service teachers to mathematics teaching programs of faculties of education by taking this condition into consideration.

The second category with the highest number of metaphors is “*FM as a strong and rare person who is eager to work*”. This category emphasizes obstacles that women are exposed to in daily life and how they are eager to work. Female mathematics teachers indicated that they had to overcome the obstacles and were taken seriously less than men, but continued their struggle. Thus, FMs may need to make more effort in order to overcome these disadvantages and prove themselves in mathematics. Adding household responsibilities to these difficulties; it is possible to state that women continue their lives in an intensive tempo (Oktay & Ozdener, 2018). It is believed that these issues cause participant teachers to perceive FMs as strong and rare people who are eager to work. The studies show that women have to struggle with some difficulties due to their gender, even though women have always worked with men in daily life from past to present. These difficulties faced by women may be “economic” (Fidan-Kocak & Isik, 2009; Kaymaz, 2010), “physical, mental” (Geary, Sauzts, & Liu, 2000; Kimball, 1989), “social, cultural” (Fan & Li, 2008; Tang et al., 2010) and “religious” (Oktay & Ozdener, 2018). Due to all these reasons, gender differences are misevaluated by some people. On the other hand, progresses that are made concerning women’s rights every passing day offer significant developments to overcome this misunderstanding in society (Wolff & Ozdemir, 2018). The number of women’s associations, communities and research centres can be increased for women to overcome social, cultural and religious difficulties. In addition, the number of symposiums, congresses or conferences that are organized every year for enhancing society’s viewpoint of women can be increased. Women’s work load can be decreased for a physical and mental relief. Finally, working women’s economic conditions can be enhanced.

According to study findings, another category is “*FM as a mysterious and complex person*”. In this category, it is seen that metaphors formed by the teachers concerning the concept of “FM” have two negative aspects. It is known that in patriarchal societies, there is a prejudice against women due to the effect of social life (Sozer & Ozkan, 2014), which may have caused female teachers to consider FMs mysterious and complex people. Just like everyone else, FMs have both positive and negative aspects and one of these aspects will come into prominence depending on the environment and men (Ozkan, 2017). It should not be forgotten that this issue is not special to women as individuals. Male mathematicians also have the same condition. Thus, there is a need for conducting similar studies for male mathematicians. In addition, instructors who would conduct the elective courses of “Social Gender Equality”, “Women and Family Life” and “Work Ethics and Values Education” being taught in undergraduate programs of faculties of education have important responsibilities for understanding women better and making them feel more valuable. Therefore, it is recommended for instructors to emphasize the importance of women in society, as well as their tasks and responsibilities in social life during these courses in order to understand women better.

According to study findings, another category is “*FM as a person with multiple roles*”. Multiple roles are the accumulation of several roles in one person depending on a variety of social statuses (Ozkanli & Korkmaz, 2000). For example, women may have statuses like teacher, housewife, mother, sister, elder sister, aunt and aunt-in-law. There might be a “role conflict” due to the aforementioned statuses (Cindogdu & Muradoglu, 1996). By the nature of these statuses, women are expected to fulfil their responsibilities. The obligation for female teachers to complete many tasks at the same time due to multiple roles may sometimes compel them in their career. As a matter of fact, while the literature examined, it is indicated that majority of women experience role conflicts and these conflicts hinder their professional development (Irey, 2011; Wall, 2008). Female teachers who experience role conflicts also have to work more than men in respect to professional development. In order to prevent this condition, it is recommended to make the working hours of female teachers more flexible.

It was determined that female teachers in this study considered themselves individuals maintaining traditional social gender roles, which was more explicit in the category of “*FM as an instructive person*”. This category shows that the participants have a positive approach to FMs shaping society. The fact that educational system reinforces traditional social gender roles causes working women to internalize these roles (Basarir & Sari, 2015). Considering that the participants consist of teachers and women, it is natural for some teachers who participated in the study to perceive themselves instructive. Since it is among teachers’ tasks to help students to reach the information and use that information (Sengul et al., 2014). Students will become ideal individuals for society and acquire necessary information and skills (Cerit, 2008) only through instructive roles of teachers. Similarly, in the literature, it is indicated that teachers have roles like “consulting” (Baki, Yildiz, Aydin, & Kogce, 2010; Yildiz & Baltaci, 2017) and “relaying and sharing information” (Baltaci, Yildiz, &

Güven, 2014; Culha-Ozbas & Aktekin, 2013; Yildiz, 2013). Achinstein and Barrett (2004) also emphasize the role of teachers as “coach” and Sengul et al. (2014) as “instructor”. Finally, it is seen that metaphors formed by the teachers under this category mainly reflect the teacher-centred approach, which gives clues about the dimensions of education received by female teachers so far. It is recommended for teachers to constantly renew themselves with not only the information obtained from undergraduate education, but also activities like in-service seminars and courses.

Educational community has accepted that individuals learn in different ways and their motivation plays an important role in this process, which has enabled teachers to focus on personal differences and motivation in education (Sugumlu, 2017; Turgut, Salar, Aksakalli, & Gurbuz, 2016). Because it is difficult to pursue the personal differences of students and keep their motivation high, it might be necessary for teachers to be self-sacrificing in this process. In this context, teachers are responsible for paying attention to personal differences, motivating their students and being self-sacrificing. As a matter of fact, the category of “*FM as a motivating and self-sacrificing person who pays attention to personal differences*” supports this condition. As is expressed in this category, the necessity for female mathematics teachers to be self-sacrificing due to multiple roles may cause them to make concessions to fundamental rights and freedoms. One of the strategies that may give women their fundamental rights and freedoms is positive discrimination (Machado-Taylor & Ozkanli, 2013). Positive discrimination can be defined as all policies, strategies, methods and applications developed on behalf of disadvantaged individuals in a society (Akbas & Sen, 2013). Working women are obliged to fulfil many tasks caused by the roles that are attributed to them by the traditional society (Alper & Safarova, 2010). Thus, it is recommended to conduct arrangements based on positive discrimination such as reducing the course hours of FMs.

While the codes examined which are formed for FMs; it was determined that the codes of “rarity” and “incomprehensibility” came into prominence. These codes may indicate that FMs are valuable but incomprehensible. In addition, some participants in the study stated that their presence in education was less than their male colleagues and they were left aside. It is known that women who constitute half of the world population are not represented in business life as much as men (Hancioglu & Citir, 2018). This condition is also observed in mathematics. While the historical development of mathematics examined, it is seen that FMs have been able to be included in mathematics after long struggles. The number of FMs who have put their signature to important studies in mathematics and put their stamp on history is considerable (Fidan-Kocak & Isik, 2009). For example, some FMs such as Hypatia, Meryem El-Usturlabi, Selma Soysal, Hulya Senkon and Meryem Mirzakhani have been more successful than male mathematicians. It will be possible to understand FMs better and increase their number by bringing the biographies of these famous mathematicians and their contributions to mathematics into the forefront. Additionally, women should not be discouraged in terms of math studies in their efforts of solving daily life problems and shaping the future in order to be equal with men (Fox, 1981).

In conclusion, the study which was conducted with female mathematics teachers can be repeated with richer sample groups. In this context, it is recommended to reveal the metaphors of pre-service mathematics teachers, secondary school mathematics teachers and academicians at universities concerning the concept of “FM”; repeat the study periodically and observe the developments and changes; conduct interviews, develop questionnaires or forms and reconsider the perceptions of female mathematics teachers concerning the concept of “FM”; examine whether the perceptions of female mathematics teachers concerning the concept of “FM” differentiate according to their marital status or state of having children or not; and use the features developed within the scope of this study in scale development studies concerning FMs. The metaphors obtained as a result of the study are considered strong clues for determining how female mathematics teachers perceive the concept of “FM”. Thus, it should not be forgotten that the metaphors can primarily be used in mathematics education as important instruments.

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Appendix A

Age: () 20-25 () 26-30 () 31-35 () 36 and older

Year of Work Experience: () 0-5 () 6-10 () 11-15 () 16-20 () 21 and older

Institute/faculty of Graduation: () Three-year training institute () Faculty of education

() Faculty of arts and sciences

Female mathematicians are like..... because.....

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