Examining the Image of Prospective Teachers towards Mathematicians

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Abstract The aim of this study is to identify how prospective teachers see mathematicians by the pictures they visualized. In accordance with this purpose phenomenology pattern which is one of the qualitative patterns was used. The study was carried out with 160 volunteered prospective teachers. The data collection tool to be used in this study consists of four parts. The first part includes questions to determine demographic characteristics of prospective teachers, second part include drawing box prepared to define images of prospective teachers towards mathematicians and open ended questions towards describing drawing, third part includes the presented options to define the image sources towards mathematicians and the fourth part includes open-ended questions to determine famous mathematicians and reasons. The images of mathematicians were analyzed by the content analyses method. When the findings of this study are examined it might be concluded that the thought of prospective teachers towards mathematicians are positive. it was determined that the prospective teachers generally perceived mathematician as with glasses, groomed, tall, spilled hairy, apronous, suited, smiling, bellied and scattered haired. When famous mathematicians are examined according to program differences, it is very important that the majority of the mathematicians on the tablature are shown by the mathematics teacher candidates and that one-third of the class teacher candidates do not recognize any famous mathematicians. It is believed that the results from at the end of the study will be helpful to training of classroom and mathematics teacher.

Keywords Concept Image, Mathematicians, Mathematics Education, Teacher Training

1. Introduction

It is known that Mathematics which is one of the oldest scientific disciplines is almost related with all scientific fields. At the same time this scientific discipline is coming across to our daily life constantly. Therefore, it is thought that everyone should have basic mathematical knowledge [1]. In fact, all teaching programs, from basic education to secondary education aim to give individuals the knowledge of mathematics which is necessary for their lives. However, the results of the researches reveal that students thinks that mathematics is generally composed of numbers and calculations, it is a difficult course to understand and the path of learning the mathematics is memorizing [2, 3, 4]. Lim and Ernest [5] is justifying that these negative opinions about mathematics are common in many countries and these negative opinions exist not only among students but also among adults. The reason why mathematics is seen as a difficult course by many people that mathematics is an abstract lesson and the comprehension phase lasts longer than the other lessons [1]. At the same time, memorizing the rules in mathematics courses and trying to gain only mathematical processing skills by applying these rules to the questions are seen as another reason for not being liked of mathematics and perceived as a difficult course [6]. For this reason, it is thought that these negative attitudes can be solved or minimized only by teaching the mathematical concepts to be embodied, and questioning the relation between rules and mathematical concepts and how these rules are obtained [7, 8]. That is, the necessity of teaching mathematical thinking more than mathematical skills is getting increasingly important [9].

Nowadays it is expected that the individuals who are raised due to the developments in science and technology can keep up with these changes, solve the problems they encounter and can produce innovation from existing information [10]. In other words, it is planned to train individuals who can turn mathematical thinking and reasoning skills into life-style [11]. For this reason, many countries give importance to effective teaching of mathematics which contributing to solving the problems that we face in daily life [12, 13]. In this context, the mathematics curriculum published in our country aims to

train individuals who have developed mathematical thinking power, who are good problem solvers and who value mathematics and learning [14]. From this point of view, it can be said that the teachers who are the practitioners of the teaching programs and organizing the learning environments have an important role in educating the individuals who have made mathematics a life style [11]. Because teachers transfer their personal feelings, thoughts and beliefs about the topic with or without awareness to the students, thereby they affect students' thoughts and attitudes [15]. It is seen here that teachers' attitudes towards mathematics and mathematicians direct the professions that students will choose. For this reason, it is considered that teacher candidate's thoughts on mathematics and mathematicians should be examined. Especially, it is seen important that disclosing the thoughts of form teacher candidates who will give the basic love of mathematics to the students in elementary school, and mathematics teacher candidates who will develop the attitudes of the students and direct their job selection towards to mathematics and mathematicians.

There are many studies in which students and prospective teachers are searched for opinions and beliefs about mathematics [16, 17, 9, 18, 19, 20, 21, 22, 23, 24, 25, 26]. However, it seems that there are only a few studies that examine the images of students and prospective teachers for mathematicians [3, 27, 28, 29, 30, 31]. When the images of mathematics emerged in these studies are examined, in the work done by Picker and Berry [3] the mathematician seems to be perceived to be more neglected, dirty, bully, threatening and male. Piatek-Jimenez [29] pointed out that as a result of a study with five female mathematics students, these students stated mathematicians as intelligent, weak in the social side, constantly thinking of mathematics and math obsessions. In his study of Norwegian students' images for mathematics, Grevholm [28] found that mathematicians were perceived as men, elderly, lonely, often wearing glasses and occasional beards. In the studies of Aguilar and her colleagues [27] with Mexican high school students, high school students seem to perceive mathematicians as male, casual or formal attire, and in some cases glasses. In addition, it is stated that mathematicians are seen as people who are happy, intelligent, enjoying work and passionate about mathematics. In our country, it has been found out that in the study done by nineteen middle school students by Ucar and colleagues [32] mathematicians were perceived as asocial, lonely, introverted, silent and nervous

people who deal with numbers in general. In the study conducted by Yazlik and Erdogan [31] with one hundred and fifty high school students, it is seen that in general mathematicians are perceived as male, middle aged, well-groomed, well-dressed, intelligent and amusing also at low rates perceived as ruthless, selfish, nervous, boring and insulting.

As a result of the literature search, a small number of researches have been found that examine the images of mathematicians. Especially in our country there is no study that comparing the thoughts of prospective teachers who will direct the students' job selection and will be a model to them in the future towards the mathematicians according to the program they are studying. Therefore, it is necessary to study the images of the candidates for mathematics and if negative images are determined, studies should be done to transfer these negative images into positive. For this reason, in this study, it is aimed to determine and compare the images towards to mathematicians of teacher candidates who are studying at elementary school mathematics, secondary school mathematics and classroom teacher education programs.

2. Method

The aim of this study is determine and compare how the prospective teachers who are studying at elementary school mathematics, secondary school mathematics and classroom teacher education programs are seeing the mathematicians on the basis of moving pictures in their minds. For this purpose, phenomenology pattern, which is one of the qualitative research patterns, has been used. In the studies where the phenomenology pattern used, it is aimed to reveal individual perceptions or perspectives related to a certain phenomenon [33].

2.1. Participants

This study was conducted with 160 prospective teachers who are studying at two state universities in Turkey and selected on a voluntary basis. The 46 percent (28.75%) of the participants are studying at the secondary mathematics teaching, 60 percent (37.50%) of them at elementary mathematics teaching and 54 percent (33.75%) of them at classroom teaching programs. Frequency and percentage values of the participants' related to age and gender are given in Table 1.

Table 1. Frequency and percentage values of the participants' related to gender and age

Age	Secondary Mathematics Teaching		Elementary Mathematics Teaching		Classroom Teaching	
	f	%	f	%	f	%
18	7	15,21	6	10,00	7	12,96
19	6	13.04	10	16,66	8	14,81
20	6	13,04	10	16,66	21	38,88
21	5	10,86	9	15,00	10	18,51
22	8	17,39	8	13,33	4	7,40
23	8	17,39	10	16,66	3	5,55
24	6	13.04	7	11,66	1	1,85
Gender	f	%	f	%	f	%
Male	13	28,26	17	28,33	17	31,48
Female	33	71,73	43	71,66	37	68,51

2.2. Data Collection

In this study, the Turkish version of a scale which was developed by Song and Kim [34] based on Draw-A-Scientist Test (DAST) by Chambers [35] is used as data collection tool. The parts, the mental images of students towards scientists and their perception of scientists around them which exist in original scale by Song and Kim [34] are not used in this study and "mathematicians" term is used instead of "scientists" term in the original scale. The scale used in this study has four parts. The first part includes questions to determine demographic characteristics of students, second part include drawing box prepared to define images of students towards mathematicians and open ended questions towards describing drawing, third part includes the presented options to define the image sources towards mathematicians and the fourth part includes open-ended questions to determine famous mathematicians and reasons. In the data collection process, information on the purpose of the study has given and the scale was distributed on a voluntary basis. The application lasted for an average of 30 minutes.

2.3. Data Analysis

Each part of scale analyzed separately within itself and analysis are conducted by two experts in the field. In the second part, the drawings of a mathematician by the prospective teachers and the answers they gave to open-ended questions to describe these drawings are coded by examining and analyzes were made for each question individually by content analysis technique. Later, the repetitive codes were categorized and thematized. The data extracted according to the theme are presented in tabular form with frequency and percentage values reflecting the differences of the programs they have studied and provided separately for each theme. In the third part of the scale, the choices of the teacher candidates were analyzed from the options presented for determining the image sources for

mathematics and the image sources of the teacher candidates for mathematics were determined. In the last part, the answers given by the prospective teachers to the open-ended questions about the determination and reasons of famous mathematicians were read one by one and analyzed by content analysis as in the second part.

Yildirim and Simsek [33] stated that a detailed report about how the data and the results obtained is an important criterion for validity in qualitative researches. The data collection and analysis processes are explained in a detailed way within this context. In order to provide reliability in this study, the data were analyzed separately by two experts and then codes and categories determined. Comparing the analysis of these two experts in the field, the numbers of overlapping and non-overlapping codes are determined. The reliability level is calculated as 94% using (Reliability = number of overlapping/(number of overlapping + non-overlapping)) formula [36]. According to Miles and Huberman [36], if the value obtained from this formula is 90% or over, it is enough for reliability. Besides, the drawings of participants are presented to provide reliability and validity while commenting themes obtained from data.

3. Findings

The findings of this study considering the subsections in the scale are given below.

3.1. The Mathematician Images in Prospective Teachers' Mind

When the answers to the open-ended questions and the drawings on which a typical mathematician image portrayed to identify the mathematician images in the minds of prospective teachers examined, it is seen that 10 female and 3 male totally 13 (28.3%) out of 46 secondary school Mathematics teacher candidates, 14 female and 2 male totally 16 (26.7%) out of 60 elementary school

Mathematics teacher candidates, and 1 female (1.85%) out of 54 classroom teacher candidates portrayed a mathematician who works on University. The rest 130 (81.3%) teacher candidates portrayed their mathematics teacher as mathematician.

As a result of the analysis of the data obtained from this part of the scale, the physical characteristics, personality characteristics, age, gender, material used, environment, interests and alternative symbols of a mathematician were obtained. The data classified according to the theme gathered later on are presented and interpreted in tabular form with frequency and percentage values reflecting the differences in the programs they have studied.

When Table 2 where the physical characteristic of the mathematician are examined, it is seen that 53.1% of prospective teachers portrayed the mathematician as spectacled, 51.9% as groomed, 34.4% as long, 31.9% as spilled hair, 27.5% as smocked, 26.9% as with suit, 25.6% as smiling, and 25% as bellied and messy hair. In addition to these 21.3% of prospective teachers portrayed the mathematician as neglected, 16.9% as scowling, 15% as sporty and 13.8% as thin.

When the physical characteristics of the mathematician are examined according to program differences; it is

observed that 32.6% of secondary school mathematics teacher candidates and 31.5% of class teacher candidates perceive mathematician as smocked and this ratio is 20% in elementary school mathematics teacher candidates. It is seen from the table that 59.7% of elementary school mathematics teacher candidates, 59.3% of classroom teacher candidates and 36.9% of secondary school mathematics teacher candidates perceived mathematician as groomed whereas 25.9% of classroom teacher candidates, 20% of elementary school mathematics teacher candidates and 17.4% of secondary school mathematics teacher candidates perceive mathematician as neglected. In addition, while elementary school mathematics teacher candidates with the 23.3% ratio and secondary school mathematics teacher candidates with the 21.7% ratio seeing the mathematicians more tired than classroom teachers, elementary mathematics teacher candidates with the 26.7% ration and classroom teachers with the 16.7% ratio seeing the mathematician more energetic than the secondary school mathematics teacher candidates. In addition to these findings, it is seen that 83.3% and 24.1% of the class teacher candidates, respectively, are portrayed mathematicians as spectacled and scowling at a higher level than the other teacher candidates.

Table 2. The physical characteristics of the mathematician in prospective teachers' mind

Physical Characteristic	Secondary School Mathematics Teaching		Elementary School Mathematics Teaching		Classroom Teaching		Total	
	f	%	f	%	F	%	f	%
Smocked	15	32,6	12	20,0	17	31,9	44	27,5
With Suit	10	21,7	17	28,3	16	29,6	43	26,9
Sporty	5	10,9	11	18,3	8	14,8	24	15,0
Groomed	17	36,9	34	56,7	32	59,3	83	51,9
Neglected	8	17,4	12	20,0	14	25,9	34	21,3
Spectacled	13	28,3	27	45,0	45	83,3	85	53,1
Beard	10	21,7	12	20,0	8	14,8	30	18,8
Mustache	5	10,9	10	16,7	9	16,7	24	15,0
Spilled Hair	15	32,6	17	28,3	19	35,2	51	31,9
Curly Hair	8	17,4	13	21,7	9	16,7	30	18,8
Messy Hair	12	26,1	20	33,3	8	14,8	40	25,0
Straight Hair	5	10,9	9	15,0	17	31,5	31	19,4
Overweight/Bellied	10	21,7	15	25,0	15	27,8	40	25,0
Thin	8	17,4	13	21,7	1	1,9	22	13,8
Long	12	26,1	17	28,3	26	48,1	55	34,4
Short	8	17,4	5	8,3	12	22,2	25	15,6
Smiling	12	26,1	16	26,7	13	24,1	41	25,6
Thoughtful	3	6,5	6	10,0	2	3,7	11	6,9
Impressive	5	10,9	11	18,3	4	7,4	20	12,5
Scowling	6	13,0	8	13,3	13	24,1	27	16,9
Tired	10	21,7	14	23,3	5	9,3	29	18,1
Energetic	4	8,7	16	26,7	9	16,7	29	18,1

When Table 3 where the personality characteristic of the mathematician are examined, it is seen that 34.4% of prospective teachers portrayed the mathematician as has good content knowledge, 28.1% as has good pedagogy knowledge, 25.6% as intelligent, 25% as witty, 25% as affectionate, 24.4% as committed to math, 24.4% as good communication with the students and again 24.4% as understanding. In addition to these 18.8% of prospective teachers portrayed the mathematician as angry, 18.1% as serious, 10% as has weak pedagogy knowledge, 9.4% as bad communication with the students and unhappy, 8.8% as has weak content knowledge and 8.1% as wiseacre.

Table 3. The personality characteristics of the mathematician in prospective teachers' mind

Personality Characteristics	Secondary School Mathematics Teaching		Elementary School Mathematics Teaching		Classroom Teaching		Total	
	f	%	f	%	f	%	f	%
Intelligent	17	36,9	15	25,0	9	16,7	41	25,6
Committed to math	15	32,6	18	30,0	6	11,1	39	24,4
Good communication with the students	8	17,4	16	26,7	15	27,8	39	24,4
Bad communication with the students	3	6,5	4	6,7	8	14,8	15	9,4
Has good content knowledge	11	23,9	24	40,0	20	37,0	55	34,4
Has weak content knowledge	2	4,3	5	8,3	7	12,9	14	8,8
Has good pedagogy knowledge	8	17,4	18	30,0	19	35,2	45	28,1
Has weak pedagogy knowledge	2	4,3	3	5,0	11	20,4	16	10,0
Endear Math	5	10,9	10	16,7	8	14,8	23	14,4
Makes Business fondly	10	21,7	11	18,3	7	12,9	28	17,5
Wiseacre	1	2,2	4	6,7	8	14,8	13	8,1
Angry	4	8,7	8	13,3	18	33,3	30	18,8
Calm	1	2,2	1	1,7	1	1,9	3	1,9
Restless	1	2,2	2	3,3	2	3,7	5	3,1
Always Thinking	3	6,5	2	3,3	0	0,0	5	3,1
Social	5	10,9	7	11,7	7	12,9	19	11,9
Asocial	1	2,2	1	1,7	7	12,9	9	5,6
Fun /Witty	6	13,0	13	21,7	21	38,9	40	25,0
Serious	7	15,2	9	15,0	13	24,1	29	18,1
Selfish	1	2,2	0	0,0	3	5,6	4	2,5
Understanding	8	17,4	10	16,7	21	38,9	39	24,4
Concerned	8	17,4	9	15,0	17	31,5	34	21,3
Helpful	4	8,7	7	11,7	14	25,9	25	15,6
Devoted	3	6,5	8	13,3	0	0,0	11	6,9
Patient	1	2,2	1	1,7	6	11,1	8	5,0
Happy	3	6,5	6	10,0	5	9,3	14	8,8
Unhappy	5	10,9	4	6,7	6	11,1	15	9,4
Self-confident	1	2,2	4	6,7	8	14,8	13	8,1
Idealist	4	8,7	12	20,0	6	11,1	22	13,8
Hardworking	9	19,6	19	31,7	3	5,6	31	19,4
Disciplined	2	4,3	12	20,0	8	14,8	22	13,8
Orderly	1	2,2	13	21,7	3	5,6	17	10,6
Compassionate	0	0,0	3	5,0	0	0,0	3	1,9
Affectionate	12	26,1	16	26,7	12	22,2	40	25,0
Respectful	2	4,3	8	13,3	0	0,0	10	6,3
Tantalizer	0	0,0	0	0,0	5	9,3	5	3,1
Having bad habits	1	2,2	5	8,3	2	3,7	8	5,0

Figure 1. A few Examples of Drawings of Prospective Teachers

Table 4. Gender of the Mathematician in prospective teachers' mind

Gender of the Mathematician	Secondary School Mathematics Teaching				Elementary School Mathematics Teaching				Classroom Teaching				Total			
	Female		Male		Female		Male		Female		Male		Female		Male	
	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%
Female	15	45,5	1	7,7	19	44,2	2	11,8	9	24,3	0	0,0	43	38,1	3	6,4
Male	18	54,5	12	92,3	24	55,8	15	88,2	28	75,7	17	100	70	61,9	44	93,6

When the personality characteristics of the mathematician are examined according to program differences; it is observed that while elementary school mathematics teacher candidates with the 30% ratio and secondary school mathematics teacher candidates with the 32.6% ratio seeing the mathematicians more committed to math than classroom teachers, elementary school mathematics teacher candidates respectively seeing the mathematicians has more content and pedagogical knowledge than the secondary school mathematics teacher candidates with 40% and 30% ratios and classroom teachers are seeing with the 37% and 35.2% ratios. In addition to these, secondary school mathematics teacher candidates perceive the mathematicians more intelligent

than the other teacher candidates with the 36.9% ratio; more makes business fondly with the 21.7% ratio and more constantly thinking with the 6.5% ratio. Elementary school mathematics teacher candidates perceiving the mathematicians more hardworking than the other teacher candidates with the 37.7% ratio, more orderly with the 21.7% ratio, more idealist with the 20% ratio, and more devoted and respectful with the 13.3% ratio. On the other hand, classroom teachers perceiving the mathematicians more witty than the other teachers with the 38.9% ratio, more concerned with the 31.5% ratio and more helpful with the 25.9% ratio but also they are perceiving them more angry than the other teacher candidates with the 33.3% ratio, more serious with the 24.1% ratio, more has weak pedagogy knowledge with the 20.4% ratio, more wiseacre with the 14.8% ratio, more asocial with the 12.9% ratio and more tantalizer with the 9.2% ratio.

71.3% of the teacher candidates portrayed the mathematician by using male figure and 28.8% by using female figure. While the figure of male mathematician is 93.6% in the drawings of male teacher candidates, this rate is 61.9% in female teacher candidates. Female mathematician figure is mostly observed in drawings of female teacher candidates. 38.1% of female teacher candidates and 6.4% of male teacher candidates used female mathematician figurines in their drawings. It is seen here that the majority of the prospective teachers perceive the sex of the mathematician as male. When gender perceptions of mathematician are examined according to program differences; 45.5% of female secondary school math teacher candidates and 44.2% of female Elementary school mathematics teacher candidates are using mathematician female figure while 24.3% of female classroom teacher candidates are using female figure.

When the findings for the age of a mathematician in Table 5 are examined, it is seen that 16.3% of the teacher candidates perceiving the mathematicians' ages between 20-29, 43.8% of them perceiving between 30-39 and 25% of them perceiving as between 40-49. In general, it can be said that teacher candidates perceive mathematicians as people between the ages of 30-49.

When the findings related to Mathematicians age were examined in terms of program differences, it is seen that 26.7% of elementary school mathematics teacher candidates, 19.6% of secondary school mathematics teacher candidates and 11.1% of classroom teacher candidates perceive mathematicians as people between 20-29 years. While 53.7% of the classroom teacher candidates and 47.8% of the secondary school mathematics teacher candidates are seeing mathematicians' age between 30 and 39, this ratio is 31.7% with the elementary school mathematics teacher candidates. In addition, only 2 (3.3%) of the participants stated that a mathematician who is a candidate for elementary mathematics teacher could be at any age.

Table 5. Age of the Mathematician in prospective teachers' mind

Age of the Mathematician	Secondary School Mathematics Teaching		Elementary School Mathematics Teaching		Classroom Teaching		Total	
	f	%	f	%	f	%	f	%
20-29	9	19,6	16	26,7	6	11,1	26	16,3
30-39	22	47,8	19	31,7	29	53,7	70	43,8
40-49	10	21,7	15	25,0	15	27,8	40	25,0
50-59	2	4,3	5	8,3	3	5,6	10	6,3
60-69	3	6,5	3	5,0	1	1,9	7	4,4
At Every Age	0	0,0	2	3,3	0	0,0	2	1,3

Table 6. The materials used by the Mathematician in prospective teachers' mind

Materials used by mathematician	Secondary School Mathematics Teaching		Elementary School Mathematics Teaching		Classroom Teaching		Total	
	f	%	f	%	f	%	f	%
Pencil	13	28,3	26	43,3	36	66,7	75	46,9
Board	11	23,9	32	53,3	45	83,3	88	55,0
Book	10	21,7	12	20,0	12	22,2	34	21,3
Lecture notes	12	26,1	5	8,3	4	7,4	21	13,1
Articles	8	17,4	7	11,7	0	0,0	15	9,4
Bag	6	13,0	1	1,7	3	5,6	10	6,3
Ruler	2	4,3	5	8,3	9	16,7	16	10,0
Compasses	0	0,0	0	0,0	3	5,6	3	1,9
Miter	0	0,0	0	0,0	3	5,6	3	1,9
Computer	2	4,3	0	0,0	0	0,0	2	1,3
Smart board	1	2,2	3	5,0	4	7,4	8	5,0
Presentation stick	0	0,0	3	5,0	3	5,6	6	3,8
Calculator	0	0,0	1	1,7	0	0,0	1	0,6
Coffee Mug	2	4,3	3	5,0	0	0,0	5	3,1

When Table 6 is examined, 46.9% of pencil, 55.0% of wood, 21.3% of books, 13.1% of lecture notes, 10% of ruler and 9.4% of articles are used as materials by mathematician in the drawings of teacher candidates. It is also seen that teacher candidates have a 5% smart board and a 1.3% computer image at low rate.

When the materials used by the mathematician are examined according to program differences, classroom teacher candidates portrayed 83.3% board and 66.7% pencil as materials used by mathematicians. In addition, it is seen that only classroom teacher candidates picture compasses and miter as a material used by the mathematician with 5.6% rate. While the articles have seen as a material used by mathematician in the 17.4% of secondary school mathematics teacher candidates' and 11.7% of elementary school mathematics teacher candidates' drawings, there has been no article in the drawings of the classroom teacher candidates.

Table 7.   The environment of the Mathematician in prospective teachers' mind

Environment of the Mathematician	Secondary School Mathematics Teaching		Elementary School Mathematics Teaching		Classroom Teaching		Total	
	f	%	f	%	f	%	f	%
Classroom	19	41,3	31	51,7	40	74,1	90	56,3
Schoolyard	16	34,8	10	16,7	11	20,4	37	23,1
Office	5	10,9	10	16,7	1	1,9	16	10,0
Lecture hall	3	6,5	0	0,0	0	0,0	3	1,9
Conference room	1	2,2	2	3,3	0	0,0	3	1,9
Workshop	0	0,0	1	1,7	0	0,0	1	0,6
TÜBİTAK	0	0,0	4	6,7	0	0,0	4	2,5
Everywhere	2	4,3	2	3,3	2	3,7	6	3,8

In the analysis of the answers to the questionnaire about the mathematicians' environment and the drawings of prospective teachers, 56.3% of the teacher candidates seeing the mathematician in classroom, 23.12% in schoolyard, 10% in office and 3.8% in everywhere.

When the environment of the mathematician is examined according to the program differences, it appears that the majority of the classroom teacher candidates (74.1%) have been portrayed the mathematician in the classroom. While 10.9% of secondary school mathematics teacher candidates and 16.7% of elementary school mathematics teacher candidates portrayed the mathematicians in office, only one (1.9%) classroom teacher candidate portrayed the mathematician in office. In addition to these, one (2.17%) of the secondary school mathematics teacher candidates and two (3.3%) of the elementary school mathematics teacher candidates saw the mathematician giving speech in the conference room. Furthermore, only the secondary school mathematics teacher candidates are seeing the mathematician in lecture hall with 6.5% rate and only elementary school mathematics teacher candidates are seeing them in TUBİTAK with 6.7% rate.

As seen in Table 8, 30.6% of the prospective teachers thinking that mathematics is the interests of the mathematician, 27.5% are teaching, 19.4% are doing sport, 16.8% are finding theorem, 15% are spending time with the students and 13.8% are giving private lessons.

When the interests of the mathematician is examined according to the program differences, secondary and elementary school mathematics teacher candidates are perceiving the mathematician's interests with higher rates than classroom teacher candidates respectively as followings; finding theorem with 21.7% and 26.7% rates, associating mathematics with daily life with 15.2% and 13.3% rates, dealing with the history of mathematics with 8.7% and 8.3% rates, and making projects with 10.9% and 3.3% rates. Moreover, it is seen that the interest of the mathematician is perceived as chess and solving Sudoku solely from elementary school mathematics teacher candidates.

Table 8. The interests of the Mathematician in prospective teachers' mind

Interests of the Mathematician	Secondary School Mathematics Teaching		Elementary School Mathematics Teaching		Classroom Teaching		Total	
	f	%	f	%	F	%	f	%
Dealing with the Math	11	23,9	21	35,0	17	31,5	49	30,6
Teaching	18	39,1	5	8,3	21	38,9	44	27,5
Associating mathematics with daily life	7	15,2	8	13,3	0	0,0	15	9,4
Finding theorem	10	21,7	16	26,7	1	1,9	27	16,9
Making Project	5	10,9	2	3,3	0	0,0	7	4,4
Dealing with the history of mathematics	4	8,7	5	8,3	1	1,9	10	6,3
Writing book	2	4,3	1	1,7	0	0,0	3	1,9
Playing chess	0	0,0	7	11,7	0	0,0	7	4,4
Solving Sudoku	0	0,0	4	6,7	0	0,0	4	2,5
Giving private lesson	2	4,3	10	16,7	10	18,5	22	13,8
Spending time with the family	1	2,2	9	15,0	4	7,4	14	8,8
Spending time with the students	2	4,3	14	23,3	8	14,8	24	15,0
Doing sport	4	8,7	18	30,0	9	16,7	31	19,4
Reading book	5	10,9	7	11,7	5	9,3	17	10,6
Dealing with music	3	6,5	6	10,0	2	3,7	11	6,9
Dealing with Literature	2	4,3	0	0,0	0	0,0	2	1,3
Dealing with the social media	1	2,2	1	1,7	2	3,7	4	2,5
Dealing with phycology	1	2,2	0	0,0	0	0,0	1	0,6
Hand arts	1	2,2	2	3,3	1	1,9	4	2,5
Dealing with trade	0	0,0	2	3,3	3	5,6	5	3,1
Dealing with garden work	0	0,0	0	0,0	4	7,4	4	2,5
Going fishing	1	2,2	3	5,0	1	1,9	5	3,1
Dealing with medicinal plants	1	2,2	0	0,0	0	0,0	1	0,6

Table 9. The alternative symbols belongs to prospective teachers' drawings

Alternative Images	Secondary School Mathematics Teaching		Elementary School Mathematics Teaching		Classroom Teaching		Total	
	f	%	f	%	F	%	f	%
Equations	10	21,7	9	15,0	17	31,5	36	22,5
Numbers	8	17,4	7	11,7	12	22,2	27	16,9
Identities	9	19,6	3	5,0	6	11,1	18	11,3
Derivative symbol	7	15,2	6	10,0	3	5,6	16	10,0
Pi number	5	10,9	7	11,7	4	7,4	16	10,0
Logarithm symbol	6	13,0	5	8,3	2	3,7	13	8,1
Polygons	2	4,3	3	5,0	8	14,8	13	8,1
Integral symbol	3	6,5	4	6,7	5	9,3	12	7,5
Trigonometry symbols	3	6,5	3	5,0	4	7,4	10	6,3
Infinite symbol	5	10,9	5	8,3	1	1,9	11	6,9
Limit symbol	5	10,9	3	5,0	0	0,0	8	5,0
Function	3	6,5	4	6,7	1	1,9	8	5,0
e number	4	8,7	3	5,0	0	0,0	7	4,4
Summation symbol	1	2,2	2	3,3	1	1,9	4	2,5
Inequalities	2	4,3	2	3,3	0	0,0	4	2,5
Sets	0	0,0	2	3,3	1	1,9	3	1,9
Field formulas	1	2,2	2	3,3	0	0,0	3	1,9
Matrices	1	2,2	1	1,7	0	0,0	2	1,3
Discriminant	0	0,0	2	3,3	0	0,0	2	1,3
Root numbers	0	0,0	2	3,3	0	0,0	2	1,3
Exponential numbers	0	0,0	1	1,7	1	1,9	2	1,3
Field formulas	1	2,2	2	3,3	0	0,0	3	1,9
Complex numbers	2	4,3	0	0,0	0	0,0	2	1,3
Coordinate plane	1	2,2	0	0,0	0	0,0	1	0,6

When Table 9 is examined, it is seen from the drawings of prospective teachers that they are using equations with the 22.5% rate, numbers with the 16.9% rate, identities with the 11.3% rate, derivative symbol and pi number with the 10% rate, and logarithm symbol and polygons with the 8.1% rate.

Secondary school mathematics teacher candidates more used equations (21.7%), identities (19.6%), numbers (17.4%) and derivative symbol (10%) in their drawings. Elementary school mathematics teacher candidates used equations (15%), numbers and pi number (11.7%) and derivative symbol (10%) in their drawings. Classroom teacher candidates more used equations (31.5%), numbers (22.2%), polygons (14.8%) and identities (11.1%) as alternative symbols in their drawings.

3.2. Image Sources of Teacher Candidates towards Mathematician

In order to determine the image sources of teacher candidates towards mathematicians, the choices of the teacher candidates on the options presented on the scale were analyzed and the image sources of teacher candidates towards mathematicians were determined and presented in Table 10.

When Table 10 is examined, it is seen that 80.6% of teacher candidates perceiving the teachers as image sources towards mathematicians, 53.1% of them biographies of mathematicians, 31.9% of them internet and 24.4% of them documentaries.

When the program differences are considered, while elementary school mathematics teacher candidates see the biographies of mathematicians as image sources of mathematician with the 65% ratio which is more than other teacher candidates, they are seeing documentaries with the 38.3% ratio. Classroom teacher candidates see the textbooks as image sources of mathematician with the 40.7% ratio which is more than other teacher candidates. In addition to these, while 13% of the secondary school mathematics teacher candidates and 13.3% of the elementary school mathematics teacher candidates showing the faculty members as image sources of mathematician, classroom teacher candidates are not showing them.

Table 10.   Image Sources of Teacher Candidates towards Mathematician

Image Sources	Secondary School Mathematics Teaching		Elementary School Mathematics Teaching		Classroom Teaching		Total	
	f	%	f	%	f	%	f	%
Teachers	36	78,3	48	80,0	45	83,3	129	80,6
Biographies of mathematicians	24	52,2	39	65,0	22	40,8	85	53,1
Internet	15	32,6	24	40,0	12	22,2	51	31,9
Documentaries	9	19,6	23	38,3	7	12,9	39	24,4
Parents	6	13,0	16	26,7	13	24,1	35	21,9
Textbooks	1	2,2	10	16,7	22	40,7	33	20,6
Science Magazines	0	0,0	16	26,7	13	24,1	29	18,1
Cartoons	5	10,9	10	16,7	7	12,9	22	13,8
Movies	6	13,0	4	6,7	7	12,9	17	10,6
Faculty members	6	13,0	8	13,3	0	0,0	14	8,8
Newspapers	3	6,5	3	5,0	1	1,9	7	4,4

3.3. Famous Mathematician

The answers given to open-ended questions by prospective teachers to identify famous mathematicians and determine the reasons for this preference are analyzed and presented in Tables 11 and 12.

When Table 11 is examined, it is seen that the most famous mathematician according to teacher candidates is Cahit Arf with 41.9% ratio and this ratio is followed by Pisagor with 31.9%, Ali Kuşçu with 23.8%, Harezmi with 17.5%, Fermat with 11.9%, and Ömer Hayyam with 10%. 14.4% of the teacher candidates stated that they do not recognize a famous mathematician. In addition, 12.5% of the prospective teachers showed their high school mathematics teacher as the famous mathematician and 5% of them showed their secondary school mathematics teacher. Also only 3 (1.9%) of the prospective teachers showed themselves as the famous mathematician. It is quite striking that Einstein, Farabi, Mimar Sinan and Yunus Emre prefer to be famous mathematicians, even though their candidates are not mathematicians. Of the mathematicians in table, it is very important that only Hypatia is women and the others are men and that only Ali Nesin is alive from these mathematicians and John Nash has recently lost his life.

Table 11. Famous mathematicians according to prospective teachers

Famous Mathematicians	Secondary School Mathematics Teaching		Elementary School Mathematics Teaching		Classroom Teaching		Total	
	f	%	f	%	f	%	f	%
Cahit Arf	7	15,2	35	58,3	25	46,3	67	41,9
Pisagor	14	30,4	18	30,0	19	35,2	51	31,9
Ali Kuşçu	2	4,3	14	23,3	22	40,7	38	23,8
Harezmi	7	15,2	17	28,3	4	7,4	28	17,5
Fermat	6	13,0	13	21,7	0	0,0	19	11,9
Ömer Hayyam	5	10,9	11	18,3	0	0,0	16	10,0
Euler	4	8,7	9	15,0	1	1,9	14	8,8
Öklid	3	6,5	10	16,7	1	1,9	14	8,8
Gauss	10	21,7	1	1,7	0	0,0	11	6,9
John Nash	8	17,4	2	3,3	1	1,9	11	6,9
Ali Nesin	5	10,9	5	8,3	0	0,0	10	6,3
İbn-i Sina	2	4,3	4	6,7	3	5,6	9	5,6
Farabi	1	2,2	4	6,7	4	7,4	9	5,6
Atatürk	2	4,3	3	5,0	3	5,6	8	5,0
Einstein	2	4,3	3	5,0	3	5,6	8	5,0
Thales	1	2,2	2	3,3	3	5,6	6	3,8
Pascal	0	0,0	1	1,7	3	5,6	4	2,5
Cauchy	3	6,5	2	3,3	0	0,0	5	3,1
Descartes	0	0,0	5	8,3	0	0,0	5	3,1
Lagrange	2	4,3	2	3,3	1	1,9	5	3,1
Hypatia	1	2,2	2	3,3	0	0,0	3	1,9
El-Kaşi	0	0,0	3	5,0	0	0,0	3	1,9
El-Kindi	0	0,0	3	5,0	0	0,0	3	1,9
Ramanujan	2	4,3	0	0,0	0	0,0	2	1,3
Leibniz	0	0,0	2	3,3	0	0,0	2	1,3
Fibonacci	1	2,2	1	1,7	0	0,0	2	1,3
Mimar Sinan	0	0,0	0	0,0	2	3,7	2	1,3
Peano	1	2,2	0	0,0	0	0,0	1	0,6
De Morgan	0	0,0	0	0,0	2	3,7	2	1,3
Riemann	2	4,3	0	0,0	0	0,0	2	1,3
El-Biruni	0	0,0	2	3,3	0	0,0	2	1,3
Abel	1	2,2	0	0,0	0	0,0	1	0,6
Yunus Emre	0	0,0	1	1,7	0	0,0	1	0,6
High school mathematics teacher	3	6,5	11	18,3	6	11,1	20	12,5
Secondary school mathematics teacher	0	0,0	6	10,0	3	5,6	9	5,6
Himself	0	0,0	3	5,0	0	0,0	3	1,9
Does not know	0	0,0	4	6,7	19	35,2	23	14,4

When Table 11 is examined, it is seen that the most famous mathematician according to teacher candidates is Cahit Arf with 41.9% ratio and this ratio is followed by Pisagor with 31.9%, Ali Kuşçu with 23.8%, Harezmi with 17.5%, Fermat with 11.9%, and Ömer Hayyam with 10%. 14.4% of the teacher candidates stated that they do not recognize a famous mathematician. In addition, 12.5% of the prospective teachers showed their high school mathematics teacher as the famous mathematician and 5% of them showed their secondary school mathematics teacher. Also only 3 (1.9%) of the prospective teachers showed themselves as the famous mathematician. It is quite striking that Einstein, Farabi, Mimar Sinan and Yunus Emre prefer to be famous mathematicians, even though their candidates are not mathematicians. Of the mathematicians in table, it is very important that only Hypatia is women and the others are men and that only Ali Nesin is alive from these mathematicians and John Nash has recently lost his life.

When the famous mathematicians examined according to program differences, elementary school mathematics teacher candidates (58.3%) and classroom teacher candidates (46.3%) are seeing Cahit Arf as the most famous mathematician and secondary school mathematics teacher candidates are seeing Pisagor (30.4%). Classroom teacher candidates preferred Ali Kuşçu (40.7%) as a famous mathematician with higher ratio than the other teacher candidates and elementary school mathematics teacher candidates preferred Harezmi (28.3%). In addition, it is seen that Gauss (21.7%) and John Nash (17.4%) are showed as a famous mathematician by the secondary school mathematics teacher candidates. It is noteworthy that the majority of the mathematicians on the table are shown as famous mathematicians by secondary and elementary school mathematics teacher candidates. It is also important to note that 35.2% of classroom teacher candidates do not recognize any famous mathematician.

According to Table 12, 44.4% of the prospective teachers showed the contribution of their studies to field as a reason why famous mathematicians are chosen, 27.5% of them the importance of their studies, 18.8% of them being Turkish and Muslim, 18.1% of them their ingratiating mathematics, 11.9% of them being intelligent and 10.6% of them showed hearing their names in the classes constantly. Despite not being a mathematician, prospective teachers have shown Einstein and Mimar Sinan as famous mathematicians because of their good knowledge about mathematics and using it on their studies. Moreover, it is noteworthy that teacher candidate who has shown Yunus Emre as a famous mathematician said that he chose Yunus Emre because he has a picture on 200 TL. Besides these, prospective teachers who showed their mathematics teachers as famous mathematicians stated that they saw them as famous mathematicians for their love of mathematics thanks to these teachers.

Table 12. Reason why famous mathematician are chosen by prospective teachers

Reason why famous mathematicians are chosen	Secondary School Mathematics Teaching		Elementary School Mathematics Teaching		Classroom Teaching		Total	
	f	%	f	%	F	%	f	%
The contribution of their studies to field	16	34,8	31	51,7	24	44,4	71	44,4
The importance of their scientific researches	9	19,6	25	41,7	10	18,5	44	27,5
Being Turkish and Muslim	6	13,0	14	23,3	10	18,5	30	18,8
Their ingratiating mathematics	4	8,7	16	26,7	9	16,7	29	18,1
Being intelligent	9	19,6	6	10,0	4	7,4	19	11,9
Hearing their names in the classes constantly	5	10,9	6	10,0	6	11,1	17	10,6
Their devotion to mathematics	8	17,4	5	8,3	2	3,7	15	9,4
Being hardworking	8	17,4	6	10,0	0	0,0	14	8,8
Being successful	0	0,0	0	0,0	12	22,2	12	7,5
Having their picture on the 10 TL	3	6,5	4	6,7	4	7,4	11	6,9
Being role model	2	4,3	6	10,0	2	3,7	10	6,3
Knowing good mathematics	1	2,2	3	5,0	4	7,4	8	5,0
Having interesting life stories	5	10,9	1	1,7	1	1,9	7	4,4
Being resolute	3	6,5	2	3,3	0	0,0	5	3,1
Being crazy	0	0,0	4	6,7		0,0	4	2,5
Being humble	0	0,0	3	5,0	0	0,0	3	1,9
Being women	1	2,2	2	3,3	0	0,0	3	1,9
Having their picture on the 200 TL	0	0,0	1	1,7	0	0,0	1	0,6

4. Discussion and Conclusions

When the drawings in which a typical mathematician image is depicted in order to determine the mathematician images in the minds of the prospective teachers are examined, it is seen that of the 160 teacher candidates, 130 of them (81.3%) draw their mathematics teachers as a mathematician and 30 of them (18.7%) draw mathematicians working at the university. In similar studies, it has been found that the students draw their own mathematics teachers as mathematicians [27, 3, 32, 31]. When the drawings of the teacher candidates were examined according to the program differences, 13 (28.3%) of 46 secondary school mathematics teachers, 16 (26.7%) of 60 elementary school mathematics teachers and 1 (1.85%) of 54 classroom teacher candidates has drawn a mathematician working in college. It can be said that one-fourth of the mathematics teacher candidates are seeing the faculty members working where they have studied as mathematicians and they are aware of that these faculty members contribute to the field of mathematics.

Another finding in this study is that 71.3% of the prospective teachers are using male figure and 28.8% of them are using female figure when they are portraying the mathematician. It is seen here that the teacher candidates perceive the sex of the mathematician as male. In addition, it was determined that the drawings in which the gender of the mathematician is reflected as a woman are mostly drawn by female teacher candidates. However, there was no illustration or explanation of the fact that being a mathematician in the drawings was not related to sex. It is seen that these findings obtained for the sex of the mathematician correspond to the findings of the studies in the literature [27, 28, 29, 3, 31]. In addition, in this study, it was determined that the teacher candidates perceived mathematics as persons between the ages of 20-49. In similar studies it was found that participants perceived mathematics as middle aged people [30, 31]. In addition, it is an important finding in this study that 2 (1.3%) teacher candidates indicate that mathematician can be at any age.

In this study, it was determined that the candidate teachers perceived mathematician as with glasses, groomed, tall, spilled hairy, apronous, suited, smiling, bellied and scattered haired. The reason why prospective teachers perceive the mathematician as groomed, suited and apronous can be showed that because the vast majority of them draw their own mathematics teachers in their drawings. In a similar research, it is reached that the students also perceives mathematician as suited and apronous [27, 31]. On the other hand, studies by Picker and Berry [3] and Grevholm [28] shows that the mathematician is perceived as more neglected and unclean. In addition to these, it is thought that the teacher candidates' perception of mathematician hair as spilled and scattered hair may be caused by the cartooning of scientists in popular culture in this way.

In the present study, it is seen that 34.4% of the prospective teachers perceiving the mathematician as has good content knowledge, 28.1% as has good pedagogical knowledge, 25.6% as intelligent, 25% as humorous, 25% as affectionate, 24.4% as devoted to the mathematics, 24.4% as has good relation with the students and understanding, 21.3% as concerning and 19.4% of them as hardworking. Whereas, it is seen that 18.8% of the prospective teachers perceiving the mathematician as serious, 18.1% as angry, 10% as has weak pedagogical knowledge, 9.4% as has bad relation with the students and unhappy, 8.8% as has weak content knowledge and 8.1% as wiseacre. When the studies related to the field are examined, it is seen that the students perceive the mathematician as intelligent, hard, angry and asocial in the studies of Ucar and his colleagues [32]. Rensaa [30] found that mathematics was seen as 41% asocial, 12% social, 61% boring and 3% fun in his study. In the study conducted by Picker and Berry [3], it appears that the mathematician is perceived as being oppressive and threatening at a high level. When the findings obtained in these studies are examined, it can be said that the opinions of teacher candidates in the present study are more positive for mathematicians. When the personality traits of the mathematician are examined according to the program differences, it is seen that the mathematics teacher candidates perceive the mathematician as intelligent, hardworking and devoted to mathematics and constantly thinking. Similarly, Piatek-Jimenez [29] found that mathematicians were perceived as intelligent, constantly mathematical thinking and obsessed with mathematics in a study with five female mathematics students. In addition to this, it is quite striking that in this study, negative characteristics such as wiseacre, angry, asocial, selfish, and tantalizer about the personality traits of mathematicians are obtained from the class teacher candidates. For this reason, classroom teacher candidates should be provided with face-to-face interviews with mathematicians and concrete experiences for mathematician should be given to these teacher candidates. Thus, it is thought that these negative opinions about the personality traits of mathematicians can be reduced or turned positive.

In this study, prospective teachers depicted mathematics in their drawings more in class, at the schoolyard and in the office. When the drawings of the teacher candidates are examined in terms of the material used by the mathematician, it is seen that the prospective teachers draw mostly pencil, board, book, lecture notes, ruler and articles also with low rates they draw smart board and computer. In parallel with these findings, the study by Aguilar and his friends [27] also showed that students perceive mathematicians as in classroom or office and they use pencils, books, chalkboards, rows and erasers to draw mathematicians' materials. When it is examined according to the program differences observed, it is determined that the mathematics teacher candidates are different from the class teacher candidates and they are seeing the mathematicians in office, lecture hall, conference room and

TÜBİTAK. Again, in the drawings of the mathematics teacher candidates, unlike the class teacher candidates, mathematicians used articles and computers. The reason for this can be showed that in the drawings of the mathematics teacher candidates, they are showing the faculty members more than the class teacher candidates' drawings. In addition, the miter and compasses are only seen in the drawings of the class teacher candidates as materials used by the mathematician. The reason for this can be showed as that class teachers use miter and compasses more when they teach geometry concepts.

Rensaa [30] has shown society, family, school life and media as an image source towards mathematicians in his work. Similarly, in the study conducted by Aguilar and his friends [27], the school environment i.e. teachers and textbooks, was identified as an image source towards mathematicians. In this study, prospective teachers showed the most teachers as image source towards mathematicians, followed by biographies of mathematicians, internet, documentary films, parents and textbooks. Based on this finding, it can be said that the mathematics teachers and mathematical experiences in the school has large part in the positive or negative opinions of the prospective teachers about the mathematicians. For this reason, the institutions that train teachers in this regard have great responsibilities. Because, in these institutions, firstly the opinions of prospective teachers about mathematics teachers and mathematicians should be determined and studies should be carried out in order to turn negative opinions into positive ones. Afterwards, prospective teachers should be informed about the students' opinions about mathematics teachers and mathematicians in mathematics teaching classes and should be trained to organize learning activities aimed at improving students' images for mathematicians. In addition to this, it can be said that in order to develop a positive image for mathematicians in the light of this finding, the work of mathematicians and their life stories should be given more place in written and visual media, internet and textbooks.

Another finding in this study is that students prefer with the highest rate Cahit Arf and then respectively Pisagor, Ali Kuşçu, Harezmi, Fermat and Omer Hayyam as the most famous mathematician. In addition, only 3 (1.9%) of the prospective teachers stated that they saw themselves as a famous mathematician. It is quite striking that Einstein, Farabi, Mimar Sinan and Yunus Emre prefer to be famous mathematicians by the prospective teachers, even though they are not mathematicians. Prospective teachers have shown Einstein and Mimar Sinan as famous mathematicians because of their good knowledge about mathematics and using it on their studies. In addition, it is a wrong generalization that the student who has chosen Yunus Emre as a famous mathematician because he has a picture on 200 TL. Of the mathematicians in table, it is very important that only Hypatia is women and the others are men and that only Ali Nesin is alive from these mathematicians and John Nash has recently lost his life. The reason why this is the case can be showed that there are no female mathematician figures in the media and in textbooks, the math is reflected as an attempt to be made only by men and that modern mathematicians are not included. For this reason, the studies of mathematicians at different gender and age levels should be introduced through the media, documentaries and textbooks. The idea that being a mathematician is not related to a certain gender or age level and that everyone who wants to be a mathematician can be one should be given. When famous mathematicians are examined according to program differences, it is very important that the majority of the mathematicians on the tablature are shown by the mathematics teacher candidates and that 35.2% of the class teacher candidates do not recognize any famous mathematicians. The reason for this can be showed as that in the field lectures of mathematics teacher candidates, they must hear the names and works of famous mathematicians and take mathematics history lessons. For this reason, it is thought that the history of science and mathematics should be added to the classroom teacher's curriculum.

As a conclusion, it is thought that in order for the prospective teachers and their students to develop a positive image about mathematician, it is necessary to understand that mathematics is an important inheritance which must be developed and possessed from generation to generation. It is also very important that the lives of famous mathematicians who contributed to the development of mathematics are explained and how important these studies were in the period when these mathematicians lived. In addition, interviews with mathematicians should be held in order for the famous mathematicians to feel that there are many mathematicians who have contributed to the development of mathematics not only in the past but also in the present. Additionally, the selection of these mathematicians from different genders and races, at all ages seems to be very important in terms of acquiring the perception that everyone can be a mathematician.

Acknowledgements

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