

**Journal of Education in Science,  
Environment and Health**

[www.jeseh.net](http://www.jeseh.net)

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Gifted Education Teachers Perceive  
Scientists and Distinguish Science from  
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ISSN: 2149-214X

**To cite this article:**

Camci-Erdogan, S. (2019). How do prospective elementary and gifted education teachers perceive scientists and distinguish science from pseudoscience? *Journal of Education in Science, Environment and Health (JESEH)*, 5(1), 119-133. DOI:10.21891/jeseh.487304

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## How Do Prospective Elementary and Gifted Education Teachers Perceive Scientists and Distinguish Science from Pseudoscience?

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### Article Info

#### Article History

Received:  
12 March 2018

Accepted:  
27 July 2018

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#### Keywords

Prospective teachers of  
gifted  
Science-pseudoscience  
distinction  
Images of scientists

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### Abstract

The present study aims to examine the perceptions towards scientists and science/pseudoscience distinctions of gifted education and elementary education teacher candidates who will educate gifted students especially at the elementary education level. A total of 92 volunteer prospective teachers, composed of candidates from gifted education and elementary education departments, participated in the study, which was carried out as a survey research. The data were collected using the Draw-a-Scientist Test and the Science/Pseudoscience Distinction Scale. The results of the study showed that both groups of prospective teachers' crafted drawings that reflected stereotypical perceptions in terms of appearance, work carried out by scientists, and gender. However, according to the results of the independent samples t-test, the elementary education teacher candidates were found to reflect more stereotypical characteristics in their drawings of scientists than the gifted education teacher candidates. The candidates' science/pseudoscience distinction scores did not significantly differ in department and there was a negative significant correlation between stereotypical image scores and scientific method scores.

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### Introduction

Today, the speed and ways of access to information is increasing. This process confronts us with many inventions and technologies that we have seen in science fiction films in the past and thought how they could be possible. While it is such a rapid process with many alternative ways to reach information, the extent to which the accessed information is scientific has become a situation which should definitely be considered. Because, today, when developments and applications such as the use of nanotechnology, the possibility of human cloning and migration to space are carried over to our daily lives, there are still also people who regulate their day or what they do or do not do according to astrological interpretations, rely on news about UFOs and reincarnation. That is why the production and use of scientific knowledge should be a responsibility not only to the scientists who have committed themselves to science but also to all the members of society. With this understanding, many countries have emphasized the importance of scientific literacy with educational reforms in order to enable the society to develop a correct and effective scientific understanding and apply it (Turgut, 2007). Therefore, in the current educational understanding, what is expected of people to do is not only to learn scientific facts, theories or laws but also to appreciate the value, power, characteristics and limits of scientific knowledge (Turgut, Akçay and İrez, 2010), and, at some point, to be able correctly grasp the nature of science.

Scientific literacy education is, especially, among the objectives to be achieved in science education in the Turkish system (MEB, 2013), but should not be limited to science education alone. In the education of scientifically literate individuals, whatever the sub-domain of science it is that is being taught, the essential point is that the nature of science should be grasped correctly (Lederman, 2007). The nature of science tries to explain what science is, how it works, how scientists work, how the society is guiding scientific knowledge and practices, and how the society reacts to these scientific applications (Ağlarıcı and Kabapınar, 2016). One of the important characteristics of scientific literacy is to distinguish between science and pseudoscience as well as knowing the sub-dimensions of science and being scientific (Norris and Philips 2003; Lederman, 2007). The basic knowledge and perceptions about the nature and nature of science are dynamic, and their knowledge and perceptions change as they develop (Suchting, 1995).

In the process of separating the scientific from the non-scientific, it is necessary to define what science is. At this point, philosophers such as Popper, Kuhn and Feyerabend try to define science and make boundaries for it but they differed on some issues like scientific process and validity criterions. These differentiations have become one of the major problem areas, especially since the early twentieth century, because they led to uncertainty

about criteria on the separation of science from non-scientific areas (Mahner, 2007). It is still a matter of debate that there may be criteria for deciding what is scientific (Eş and Turgut, 2018). In this point, it is important that the demarcation of scientific and pseudoscientific knowledge is carried out; but an open, indisputable series of criteria that can be applied in any case for a definite demarcation has not yet been established (Turgut, 2011). However, it can be acted on some criteria suggested by different philosophical movements philosophers (Çetinkaya, Turgut and Duru, 2015). The falsifiability of scientific knowledge, its subjectivity, its inclusion of imagination and creativity for the benefit of people, its being a combination of observations and inferences, and its being influenced by social and cultural contexts can be regarded as the accepted criteria in assessing whether any emerging information is scientific or not (Lederman, 1999; Abd-El-Khalick and Lederman, 2000). In order for a solution to a problem to be scientific, it must be logical, correct, and depend on reliable observations and experiments. None of the forms of non-scientific solutions meet these three conditions. The disciplines that do not meet all of these conditions but bear one or two are defined as pseudoscience (Yıldırım, 2010). These disciplines are claimed to be scientific but are thoughts that cannot experimentally be tested (Preece and Baxter, 2000).

In order to overcome difficulties in demarcation, in Smith and Sharmann (1999)' approach, the question "What are the features that do or do not make a field more scientific ?" is seen as basic problem rather than the question of "Is this scientific or not ?" and a field revealed is judged by whether it is more scientific or less scientific. According to Smith and Sharmann (1999 the characteristics that make an field more scientific are "The object and Process of Study" and "Values of Science"; the characteristics that make a field less scientific are "Espousing a Theological Position", "Valuing Authority over Evidence "and" Fideism". When we look at the approaches in the literature, it can be said that this approach is better suited then giving certain lines for scientific or non-scientific (Eş and Turgut, 2018). Every day there are lots of news about information that is claimed to be scientific through the Internet, newspapers or televisions. Many individuals who cannot distinguish between science and pseudoscience easily make mistakes and suffer material and spiritual harm. For this reason, in particular, some criteria are needed to decide whether this information is scientific or pseudoscientific. Accordingly, as the number of scientifically literate individuals in the society increases, it will not be wrong to say that the views of the community towards science will improve (Driver et al., 1996).

One of the important influences in improving the scientific literacy levels of individuals in society is the proper settlement of perceptions about scientists, their characteristics, how they work and who can do science. The interest in and perceptions about science and scientists are very important in making scientific knowledge more accessible (Camci-Erdogan, 2018). Considering that the bases of the first science experiences of individuals are established in the elementary education, teachers' attitudes and the learning environment they prepare are influential on the interest, attitudes and performances of elementary school students towards science and scientists (Carnes 2009; Christidou 2011; She and Fisher, 2002; Sönmez, 2007, Washton, 1971). However, students who develop negative attitudes toward science and scientists do not see scientific subjects as interesting and do not want to choose a course or profession related to science in the future (Hammrich, 1997; Milford and Tippet, 2013).

Gifted students have an inherent interest in scientific subjects because such subjects nurture their instinctual curiosity and motivation (SmutnyVon and Fremd, 2004). They have the ability to transfer inferences from different events and situations to unusual situations in everyday life (Kopelman, Galasso and Strom, 1977; Ngoi and Vodracek, 2004). They achieve such inferences through scientific processes by closely observing their environments (Karnes and Riley, 2005), by recognizing and identifying the problems that others have missed (Meador, 2003), and by enjoying the exploration of open-ended problem situations. They have a passion including motivation, insistence, discovery skills and natural ability towards scientific subjects. It can be said that these students with characteristics such as being highly interested in exploring scientific events, being inclined to observe and ask questions, and having a deep interest in any discipline of science (Cooper, Baum and Neu, 2004, 2005; Taber, 2007) are the individuals who have a prominent role in the production of scientific knowledge or in its effective use. Accordingly, it would not be wrong to say that giving precedence to the education of gifted students is one of the most valuable investments that a society can make towards its future. Teachers who will educate gifted students should be at a level that can support and push forward such motivation, desires and interests of the students, because elementary teachers are one of the primary sources of information for science and scientists, and the influence they have on their students cannot be denied (Matthews and Davies, 1996; Christidou 2011; Moseley and Norris, 1999).

At the level of elementary education, students get introduced to subjects like science, scientific knowledge, and scientists in the formal sense or improve their knowledge on such knowledge areas with the help of their teachers (Turgut et al., 2016). In our current education system, a gifted student is educated at the elementary level either

by an elementary teacher or by a gifted education teacher who has been appointed as an elementary teacher. At this point, the perception, attitudes and beliefs that the prospective teachers of elementary education and gifted education — who are more likely to work with gifted students in the first stages of elementary education — have towards science and scientists are very important.

It should be among the targets of teacher education institutions to know the views of prospective teachers who will educate future scientifically literate individuals about scientists and scientific/non-scientific activities and to try to overcome their misconceptions about these issues (Ağlarıcı and Kabapınar, 2016). The reason is that teacher candidates' views on science and science subjects are based on their experiences in their own school years. Their views are very rooted and resistant to change (Hewson and Hewson, 1989). Since the study of Mead and Metraux (1957) on high school students' perceptions towards scientists, many studies have been carried out on different groups. Studies were carried out on such as elementary students (Buldu, 2006; Kaya, Doğan and Öcal, 2008; Türkmen, 2008), elementary and secondary students as a comparison (Akçay, 2011; Fung, 2002, secondary students (Camci, 2008; Gonsoulin 2001; Song and Kim, 1999), secondary gifted students (Camci-Erdogan, 2013a, 2013b; Kemaneci, 2012; Turgut, Öztürk and Eş, 2017). Based on these studies carried out with students it has been revealed that participants mostly have a stereotypical perception towards scientists whom they perceived as a middle-aged, lonely male wearing a laboratory coat and glasses and experimenting in a laboratory. Studies in the literature are mostly concerned with the students but also some studies conducted with the teacher candidates. These studies are mostly conducted with elementary teacher candidates (Çermik, 2013; Reap, Cavallo and McWhirter, 1994; Ünver, 2010), mixed groups (science, social studies, elementary, music etc.) (Bozdoğan, Şengül and Bozdoğan, 2013; Moseley and Norris, 1999; Özkan et al., 2017; Ürey et al., 2017). When looking at the results of available research, similar to the work done by the students in the studies conducted with the prospective teachers, it has been revealed that mostly the teacher candidates have stereotypical image of scientists as middle aged lonely men working with laboratory materials in a closed environment. As a result of these studies, stereotypes for scientists are formed at the level of elementary education and continue for many years or even for life. So it is important to determine image of elementary teachers of gifted students who have are thought to play an important role because of their potential. But researcher had reached only one study conducted with gifted education teacher candidates (Camci-Erdogan, 2018) who will give the initial guidance and effect in the academic and scientific life of gifted students.

Considering the studies focusing on the distinction between science and pseudoscience, many studies have been carried out on teacher candidates (Ağlarıcı and Kabapınar, 2016; Ayvaci and Bağ, 2016; Berkant and Ermeydan, 2017; Çetinkaya, Laçın-Şimşek and Çalışkan, 2013; Kallery, 2001; Losh and Nzekwe, 2011; Saka and Sürmeli, 2017; Şenler and İrven, 2016; Turgut, 2009; Turgut et al., 2016; Yates and Chandler, 2000) and teachers (Berkman, Pacheco and Plutzer, 2008; Eve and Dunn, 1990; Nehm and Schonfeld, 2007). It is seen that in our country, Turkey, studies focusing on the distinction between science and pseudoscience mostly have included prospective science teachers (Ağlarıcı and Kabapınar, 2016; Çetinkaya, Laçın-Şimşek and Çalışkan, 2013; Saka and Sürmeli, 2017; Turgut, 2009; Turgut, 2011; Turgut, Akçay and İrez, 2010) who are regarded as the most important and responsible individuals for raising scientifically literate individuals. The task prospective science teachers have in terms of raising scientifically literate individuals is obvious. However, in the framework of formal education — especially at the elementary education level — the first teachers the students will work with to study scientific literacy will be the elementary school teachers. The first teachers the gifted students will work with in the same manner will be the gifted education teachers. Gifted students share their first official science practice with elementary education and gifted education teachers. For this reason, the role of elementary and gifted education teachers is crucial as the first step in scientific literacy, scientific skills and in general science education (Akerson, Buzzelli & Donely, 2010). So the aim of the present study is therefore to determine the perceptions towards scientists and science/pseudoscience distinctions of gifted and elementary education teacher candidates who will give education to gifted students at the elementary level and guide them to the exploration, use and production of scientific knowledge. For this purpose, research problems are as follows:

1. What are images of scientists of candidate elementary education and candidate gifted education teachers according to departments?
2. Do teacher candidates differ in stereotypical image scores of scientists according to department?
3. Do teacher candidates differ in science/pseudoscience distinction scores according to department?
4. What are images of scientists of candidate elementary education and candidate gifted education teachers according to genders in department?
5. Do teacher candidates' stereotypical image mean scores differ according to gender in departments?
6. Do teacher candidates' science/pseudoscience distinction mean scores differ according to gender in departments?

7. Is there any correlation between stereotypical image scores and science/pseudoscience distinction scores?

## Method

### Design of the Study

This study was carried out as a survey research with the aim of determining science/pseudoscience distinction levels of prospective teachers of elementary and gifted education and their perceptions towards scientists.

### Participants

The sample of the study consisted of 92 teacher candidates who were studying in 4th (last) grade of the Gifted Education and Elementary Education undergraduate departments at a state university located in Istanbul in the academic year of 2016–2017. The convenience sampling method, one of the purposive sampling methods (Creswell, 2012; Yıldırım and Şimşek, 2008), was adopted when determining the sample. The participant was given information about the subject of study by the researcher in separate groups as elementary and gifted education department. Participants voluntarily participated in the study. Seven students were excluded from the study because they did not have drawings for scientists and they responded some items multiple times on likert type scales. The department and gender distribution of the candidates participating in the study is given in Table 1. Table 1 shows that there were 43 (86%) female and 7 (14%) male participants from the elementary education department, and 30 (85.7%) female and 5 (14.3%) male participants from the gifted education department.

Table 1. Frequency and percentages according to department and gender

Department	Gender	f	%
Elementary Education	Male	7	14
	Female	43	86
	Total	50	100
Gifted Education	Male	5	14.3
	Female	30	85.7
	Total	35	100

### Data Collection Tools

#### *Draw-a-Scientist Test (DAST)*

The Draw-a-Scientist Test (DAST) (Chambers, 1987) was used to determine the data for the perceptions towards the scientists in the study. This was a test that allowed people to draw pictures to explain their thoughts about scientists. In this test, the students were given the following instruction: “Please close your eyes and imagine a scientist working. Open your eyes and draw the scientist you imagined.” Underneath the blank area for drawing was a field for the students to mark the age and gender of the scientist. Drawing ideas and perceptions towards scientists is an advantage for DAST in terms of allowing participants to express their own ideas freely and to facilitate its implementation (Öcal, 2007).

#### *Science/Pseudoscience Distinction Scale*

The Science/Pseudoscience Distinction Scale was used in obtaining science and pseudoscience distinction scores of the teacher candidates. The original of the scale was developed by Oothoudt (2008) and adapted to Turkish by Çetinkaya, Laçın-Simşek and Çalışkan (2013). The scale consisting of 23 Likert-type items had four sub-dimensions as “Pseudoscience, Scientific Method, Science/Pseudoscience Distinction and Pseudoscientific Beliefs.” The Cronbach-alpha coefficient of the adapted scale had been found to be .75 as a result of the reliability analysis, while its Cronbach-alpha coefficient of scale was .73 and four sub-dimensions as Pseudoscience, Scientific Method, Science/Pseudoscience Distinction and Pseudoscientific Beliefs were successively .75, .71, .69 and .68 in the present study.

## Data Collection and Analysis

The two scales were applied together to the volunteer teacher candidates. In the analysis of teacher candidates' drawings regarding scientists, the Draw-a-Scientist Checklist (DAST-C) developed by Finson, Beaver and Cramond (1995) was used. When the variables were coded, the expressions that reflected stereotypes in perception towards scientists were coded as 1, and their absence was coded as 0. The stereotypes towards scientists were coded as follows:

1. Laboratory Coat: In the drawings of teacher candidates, if the scientist wore a lab coat, this was coded 1. If the scientist was not wearing one, it was coded 0.
2. Glasses: This was coded 1, if the scientist was wearing eyeglasses. It was coded 0, if the scientist was not wearing them.
3. Beard/Mustache: If the scientist was wearing any combination of beard, mustache or sideburns, this was coded 1. If not, it was coded 0.
4. Messy-looking: If the scientist was messy-looking, it was code 1. If not, it was code 0.
5. Research Symbols: If there was a beaker, volumetric flask, lame/lamella, solution, or any similar laboratory equipment in the drawings, this was coded 1. If there was no laboratory equipment, it was coded 0.
6. Information Symbols: If there were symbols in the drawings, such as a book, file, pen, or note, this was coded 1. If there were no symbols, it was coded 0.
7. Technology Symbols: The presence of any technological objects such as a television, telephone, robot, computer, microscope, or telescope was coded as 1. Their absence was coded as 0.
8. Gender: If the scientist was male, this was coded 1. If the scientist was female, it was coded 0.
9. Lonely Working: If the scientist was working alone, it was code 1. If not, it was coded 0.
10. Working Environment: If the scientist was working in a closed interior (such as a laboratory or library), this was coded 1. If the scientist was working outside, it was coded 0.
11. Age of the Scientist: If the scientist's age was expressed as 40 or more, this was coded 1. If it was expressed as 39 or below, it was coded 0.

The increase in the scores received by the prospective teachers indicates that they reflected more stereotypical characteristics in their drawings. In the study, two experienced experts evaluated 10% of the number of participants (10 participants) together during the evaluation of scientist drawings. Experts shared their decisions with each other after they have completed coding individually. Each of them declared their ideas on codes that are not consensus. They convince each other through this idea sharing and then they negotiated the codes on which they did not agree to come up with the final codes. The Science/Pseudoscience Distinction scale was applied in collectively to both groups and given as long as participants wished to participate. Since the collected data was likert type, it was coded 1 for "I strongly do not agree", 2 for "I do not agree", 3 for "I am undecided", 4 for "I agree" and 5 for "I strongly agree". Reverse encoded items are corrected. In addition, skewness and kurtosis coefficients were checked based on the analyses to examine whether the data were normally distributed. The skewness and kurtosis coefficients calculated for the stereotypical scientist perception score were .648 and .845, and for the Science/Pseudoscience Distinction score, .454 and .021, respectively. According to these results, frequency, percentage, independent samples t-test and correlational analysis were used in the analysis of the data showing normal distribution.

## Results

### *1. What are images of scientists of candidate elementary education and candidate gifted education teachers according to departments?*

Table 2 shows that almost half (44%) of the prospective elementary teachers described a scientist with a laboratory coat, while 14.3% of the prospective gifted education teachers described a scientist with a laboratory coat. Both elementary education and gifted education teacher candidates drew scientists with an almost 50% messy-looking image. 88% of elementary education teacher candidates portrayed the scientist with research symbols such as a beaker, volumetric flask and test tube, while 40% of prospective teachers of gifted education used these symbols. Symbols such as books and desktop notes were used at 50% level in both groups. While more than 50% of elementary education teacher candidates described the scientist as a male, more than 50% of the prospective teachers of gifted education described the scientist as a female. A great majority of both groups drew scientists as a person working alone (100% and 85.7%, respectively) indoor (90% and 74.3%,

respectively). More than half of the teacher candidates in both groups portrayed that the scientist was 10 to 39 years old.

Table 2. Frequency and percentages of stereotypes according to department

Codes	Elementary Education		Gifted Education	
	f	%	f	%
Laboratory Coat	22	44	5	14.3
Glasses	20	40	8	22.9
Beard/Mustache:	6	12	2	5.7
Messy-looking	25	50	17	48.6
Research Symbols	44	88	14	40
Information Symbols	24	48	19	54.3
Technology Symbols	5	10	14	40
Male	30	60	13	37.1
Female*	19	38	19	54.3
Lonely Working	50	100	3	85.7
Working Inside	45	90	26	74.3
At the age of 40 and up	21	42	11	31.4

\* Even though the code of female image was not on the markers as a stereotype, it was included in the table because it was an important finding for study.



Figure 1. Sample image belongs to a gifted education teacher candidate

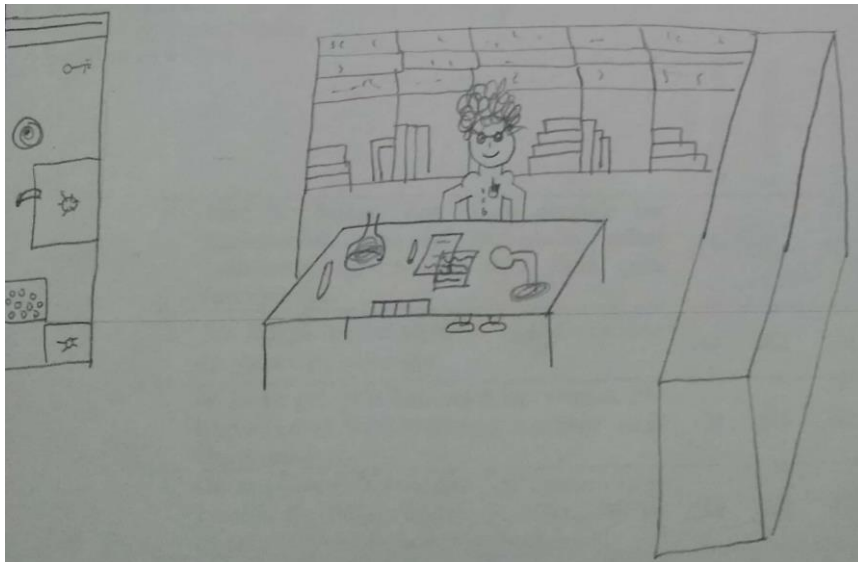


Figure 2. Sample image belongs to a elementary education teacher candidate

2. Do teacher candidates differ in stereotypical perception scores of scientists according to department?

Table 3 shows that the stereotypical perception scores of the prospective teachers had a statistically significant difference in terms of the department in which they studied ( $t=2.76, p<.05$ ). At this point, it was revealed that the teacher candidates who were studying in the department of elementary education had more stereotypical images in terms of perception towards scientists than those who studied in the department of gifted education.

Table 3. Independent t test analysis for images: Department

	Department	N	Mean	Std. Deviation	t	df	p
Stereotypical perception scores	Elementary Education	50	6	2.109	2,76	83	.007*
	Gifted Education	35	4.69	2.223			

\* $p<.05$  There was a significant difference.

3. Do teacher candidates differ in science/pseudoscience distinction scores according to department?

Table 4 shows that the scores obtained from the science/pseudoscience distinction scale of the prospective teachers of elementary education and gifted education did not differ significantly based on their departments, neither in any of the sub-scales — specifically, pseudoscience ( $t=.201, p>.05$ ), scientific method ( $t=-1.162, p>.05$ ), science/pseudoscience distinction ( $t=1.318, p>.05$ ), pseudoscientific beliefs ( $t=-.327, p>.05$ ) — nor in the whole of the scale ( $t=.115, p>.05$ ).

The mean scores of the teacher candidates taken from the sub-dimensions and the overall scale were evaluated according to their average weight values. The ranges in the 5-point Likert type scale were determined to be 1.0–1.8, 1.9–2.6, 2.7–3.4, 3.5–4.2 and 4.3–5.0 for “Very Low,” “Low,” “No Idea,” “High” and “Very High,” respectively (Ayvaci and Bağ, 2016). The average scores of the gifted education and elementary education teacher candidates show that both groups were in the level of “No idea” in terms of the pseudoscience and pseudoscientific beliefs sub-dimension. The scores of the groups in the scientific method and science/pseudoscience distinction sub-dimensions and in the whole scale were all “High.”

Table 4. Independent t test analysis for science/pseudoscience distinction: Department

Science/pseudoscience distinction scale scores	Department	N	Mean	Std. Deviation	t	df	p
Pseudoscience	Elementary Education	50	3.04	.387	.210	90	.834
	Gifted Education	35	3.02	.508			
Scientific method	Elementary Education	50	3.93	.415	-1.162	90	.248
	Gifted Education	35	4.03	.332			
Science/pseudoscience distinction	Elementary Education	50	4.05	.465	1.318	90	.191
	Gifted Education	35	3.91	.539			
Pseudoscientific beliefs	Elementary Education	50	3.23	.608	-.327	90	.745
	Gifted Education	35	3.28	.798			
Whole of the scale	Elementary Education	50	3.60	.266	.115	90	.909
	Gifted Education	35	3.59	.303			



4. What are images of scientists of candidate elementary education and candidate gifted education teachers according to genders in department?

The percentages, frequencies and averages of scores were compared in gender comparisons rather than independent sample t test because of the difference in the distribution between male and female students.

Table 5. Frequency and percentages of stereotypes according to gender in departments

Codes	Gifted Education				Elementary Education			
	Male		Female		Male		Female	
	f	%	f	%	f	%	f	%
Laboratory Coat	1	20	4	13.3	1	14.3	21	48.8
Glasses	2	40	6	20	3	42.9	17	39.5
Beard/Mustache	0	0	2	6.7	1	14.3	5	11.6
Messy-looking	4	80	13	43.3	5	71.4	20	46.5
Research Symbols	2	40	12	40	3	42.9	41	95.3
Information Symbols	3	60	16	53.3	1	14.3	23	53.5
Technology Symbols	2	40	12	40	2	28.6	3	7
Male	4	80	9	30	7	100	23	53.5
Female*	1	20	18	60	0	0	19	44.2
Lonely Working	5	100	25	83.3	7	100	43	100
Working Inside	5	100	21	70	4	57.1	41	95.3
At the age of 40 and up	3	60	8	26.7	5	71.4	16	37.2

\* Even though the code of female image was not on the markers as a stereotype, it was included in the table because it was an important finding for study.

Table 5 shows that the female teacher candidates in elementary education department drew the scientists with laboratory coat (48.8%) and glasses (39.5%) with a higher percentage than the female candidates of gifted education department (13.3%; 20%, respectively). Almost all female elementary teacher candidates used research symbols in their drawings (95.3%), while less than half of the female gifted teacher candidates (40%) used research symbols in their drawings. From the point of view of the use of the technology symbols, it was seen that female gifted education teacher candidates reflected higher percentage than female elementary education teacher candidates.

While almost all of male teacher candidates in both groups drew male scientist, the situation in female teacher candidates is different. While 30% of the female gifted education teacher candidates drew male scientists, 60% of them drew female scientists. And 53.3% of the female elementary teacher candidates drew male scientists, 44.2% of them drew female scientists. Teacher candidates in both groups have dreamed and drew scientists working alone and indoors at high percentages. When we look at the age of the drawn scientists, it has been seen that female gifted teacher candidates have drawn scientists over 40 years with a lower percentage than female elementary teacher candidates. In other words, female gifted education teacher candidates tend to imagine scientists to be under 40 years old.

5. Do teacher candidates' stereotypical perception mean scores differ according to gender in departments?

Table 6 shows the results of the descriptive analysis in order to see the difference difference between the scores of stereotypical perceptions towards scientists according to the gender of candidates in departments.

Table 6. Descriptive values of stereotypical perception scores due to gender in departments

Stereo typical perception scores	Department	Gender	N	Min	Max	Mean	Std. Deviation
		Gifted Education	Male	5	4	10	6.40
		Female	30	0	10	4.40	2.094
Elementary Education		Male	7	4	8	5.57	1.813
		Female	43	3	13	6.07	2.165

The low level of stereotypical perception scores is interpreted as the fact that teacher candidates reflect less stereotypical images of scientists. In this context Table 6 shows that the average stereotypical perception scores

of female gifted education teacher candidates ( $\bar{x}=4.40$ ) was lower than the average stereotypical perception scores of female elementary education teacher candidates ( $\bar{x}=6.07$ ). From the point of view of male candidates, it is seen that the average scores of elementary teacher candidates ( $\bar{x}=5.57$ ) are lower than those of gifted education teacher candidates ( $\bar{x}=6.40$ ).

6. Do teacher candidates' science/pseudoscience distinction mean scores differ according to gender in departments?

Table 7 shows the descriptive values of science/pseudoscience distinction scores and the mean scores of the teacher candidates taken from the sub-dimensions and the overall scale were evaluated according to their average weight values. The ranges in the 5-point Likert type scale were determined to be 1.0–1.8, 1.9–2.6, 2.7–3.4, 3.5–4.2 and 4.3–5.0 for “Very Low,” “Low,” “No Idea,” “High” and “Very High,” respectively (Ayvaci and Bağ, 2016). The average scores of the gifted education and elementary education teacher candidates show that all groups were in the level of “No idea” in terms of the pseudoscience sub-dimension. Male gifted education teacher candidates were at “High level” while all the other groups were in the level of “No idea” in terms of pseudoscientific beliefs sub-dimension. The scores of the groups in the scientific method and science/pseudoscience distinction sub-dimensions and in the whole scale were all “High.”

Table 7. Descriptive variables of science/pseudoscience distinction scores due to gender in departments

Department	Gender	Scale	N	Min	Max	Mean	Std. Deviation
Gifted Education	Male	Pseudoscience	5	2	4	3.11	.814
		Scientific method	5	4	5	4.29	.286
		Science/pseudoscience distinction	5	3	4	3.77	.560
		Pseudoscientific beliefs	5	2	5	3.60	1.01
		Whole of the scale	5	3	4	3.70	.219
	Female	Pseudoscience	30	2	5	3.00	.458
		Scientific method	30	3	5	3.99	.323
		Science/pseudoscience distinction	30	3	5	3.93	.541
		Pseudoscientific beliefs	30	2	5	3.22	.765
		Whole of the scale	30	3	4	3.57	.314
Elementary Education	Male	Pseudoscience	7	3	3	2.87	.212
		Scientific method	7	3	4	4.04	.486
		Science/pseudoscience distinction	7	4	5	4.07	.286
		Pseudoscientific beliefs	7	2	4	3.10	.630
		Whole of the scale	7	3	4	3.57	.189
	Female	Pseudoscience	43	2	4	3.07	.402
		Scientific method	43	3	5	3.92	.428
		Science/pseudoscience distinction	43	3	5	4.04	.498
		Pseudoscientific beliefs	43	2	5	3.25	.600
		Whole of the scale	43	3	4	3.61	.287

7. Is there any correlation between stereotypical image scores and science/pseudoscience distinction scores?

Table 8 shows, there was a negative significant correlation between stereotypical image scores and scientific method scores [ $r(85)=-.221$ ;  $p<.05$ ). That means stereotypical image score increases while the scientific method score decreases. As the image of the scientist is stereotyped, the individual move away from the scientific method.

Table 8. Correlation values between stereotypical image scores and science/pseudoscience distinction scores

	Whole of the scale	Pseudoscience	Scientific method	Science/pseudoscience distinction	Pseudoscientific beliefs
Stereotypical image score	-.154	-.081	-.221*	-.074	-.036

\*Correlation was significant at the .05 level.

## Discussion and Conclusion

Based on the image of scientists and the level of science/pseudoscience distinction levels of prospective teachers of gifted education and elementary education, it was revealed that the prospective teachers reflected stereotypical perceptions towards scientists in their drawings in general. In the same way as many studies in the literature (Bozdoğan, Şengül and Bozdoğan, 2013; Camci-Erdogan, 2018; Çermik, 2013; Moseley and Norris, 1999; Özkan et al. 2017; Reap, Cavallo and McWhirter, 1994; Şenel and Aslan, 2014; Ünver, 2010; Ürey et al. 2017) the teacher candidates of both gifted education and elementary education portrayed scientists mainly as a middle-aged, messy-looking person wearing a laboratory coat and glasses and working alone on chemicals in the laboratory. As a result of comparison between the two groups based on the stereotypical images in the drawings of scientists, it was revealed that the teacher candidates of elementary education had more stereotypical image and perception for scientists. This may have been due to the fact that the gifted education students had to take very different courses in the teacher education program, differently from the elementary education program, and in these courses they had seen different scientists (difference in gender, age, ethnicity etc.) and different ways of thinking. It may be effective, however, to take a number of lessons on the creation and development of scientific knowledge and scientific method and to participate in different projects supported at the national level in order to guide the gifted students on their curiosity about science and scientific method. It would not be wrong to say that the teacher candidates' drawings are rooted in the belief that it is exhausting and backbreaking to do science based on the presence of messy-looking scientists wearing glasses (Camci-Erdogan, 2018; Ünver, 2010; Yontar-Toğrol, 2000). Nevertheless, it is necessary to keep in mind that doing science is perceived as working in the laboratory alone, in isolation from society, based on the drawings portraying scientists working behind closed doors alone. Similar results have been found in previous studies and it has been emphasized that the figures of scientists used in textbooks in the Internet, visual and printed media seriously affect the formation of these images (Camci-Erdogan, 2013a, 2013b; Camci-Erdogan, 2018; Schibeci, 1986; Song and Kim, 1999; Yontar-Toğrol, 2000).

When the teacher candidates' drawings of scientists are considered in terms of what scientists do, it turns out that a great majority of the prospective teachers of both groups but especially female elementary teacher candidates (95.3%) reflect scientists only as someone experimenting with chemicals in the laboratory. This leads students to not see alternatives in terms of scientific literacy with regard to how scientific knowledge is produced, ways of reaching scientific knowledge, and how scientists work, which limits the perception about scientific knowledge only to sciences.

One of the most important stereotypes for the perception towards the scientist is imaging a man. In almost all of the studies on the topic, a large part of students or teacher candidates have described the scientists as males (Buldu, 2006; Camci-Erdogan, 2013a, 2013b; Chambers, 1983; Çermik, 2013; Flick, Fort and Varney, 1989; Fung, 2002; Gonsoulin, 2001; Kaya, Doğan and Öcal, 2008; Kemaneci, 2012; Mead and Metraux, 1957; Narayan et al., 2007; Schibeci, 2006; Song and Kim, 1999; Symington and Spurling, 1990; Türkmen, 2008; Ünver, 2010; Yontar-Toğrol, 2000). In the present study, while the vast majority of the prospective female elementary education teachers drew male scientists, the majority of the prospective female gifted education teachers drew female scientists. This is particularly promising in terms of breaking the notion that doing science is specific to men, and in establishing the idea that there are and will be female scientists in all areas of science (especially in physical sciences). In particular, female gifted students have a great need for their skills to be supported by role models in terms of expressing themselves on scientific platforms and not concealing themselves (Camci-Erdogan, 2013a; Camci-Erdogan and Riga, 2016). Because gifted girls mask their potential in scientific issues and it is known as an important problem on the field (Camci-Erdogan, 2013a), Therefore, it is very important for the teacher to convey to students the perception that science can be done at an equal level in terms of both genders in society. And gifted education candidates should have knowledge at the point of showing correct role models to girls in scientific fields.

When we look at the age range chosen by the prospective teachers of both gifted education and elementary education to portray a scientist in their drawings, about age, both groups portrayed scientists at 30–40 age range. It cannot be denied that science is still influenced by printed media, visual media and Internet tools in terms of confining science to an age level, which can be considered a middle age in general. At this point, it can be said that, in terms of scientific literacy, we lack the emphasis that science is for all ages, and that science can be done by everyone from birth to death. The fact that scientists were working in isolation from the society in the drawings of prospective teachers confirms the perception that science cannot be done by anyone, but only by certain people. Therefore, to properly structure scientific literacy, it must be emphasized that science can be understood and done by all.

Considering the science/pseudoscience distinction scores of both groups, it was seen that prospective teachers were undecided or had no opinion on the expressions in the sub-dimension of the pseudoscience and pseudoscientific beliefs. However, it was revealed that scores of both groups were high in the scientific method, science/pseudoscience sub-dimensions and in the whole of the scale. Teacher candidates made more precise, clear and accurate decisions on issues such as scientific method and scientific research. Candidates were undecided about the pseudoscience-related issues (e.g., “Houses are visited by the ghosts of the deceased people.”) and expressed their lack of ideas. However, it is also evident that the scientific method subscale is correlated reversely to the stereotypes about scientists. At this point, it has emerged that prospective teachers who have mastered the scientific method process have less stereotypes for scientists. People believe in pseudoscientific explanations because pseudoscientific explanations are given scientific implications (Yıldırım, 2008) and pseudoscientific explanations are easier to understand than scientific explanations (Lindeman, 1998). However, the individual who knows the formation and characteristics of scientific knowledge can distinguish and put into practice scientific thought from pseudoscientific thought (Lederman, 2007). Teacher candidates familiarize with content related to scientific methods that they receive in the Scientific Research Method course and in other courses. It can be said that such contents are effective in teaching them to make more accurate and clear decisions about scientific methods. At this point, it is understood that it is necessary to offer courses with content focusing on the nature of science and what characteristics should be considered in distinguishing scientific explanations from pseudoscientific explanations, as well as emphasizing the importance of assessing the source of information.

It is very important to make the right beginnings in the learning process, because it is difficult to change the incorrect understandings, prejudices or stereotypes. Studies conducted with gifted students show that these students are thought to be reached scientific evidence through empirical evidence, they are largely focused on the scientific process and in this context they are more likely to portray male scientists using glasses and laboratory coats using experiment apparatus (Camci-Erdogan, 2013a, 2013b; Turgut, Öztürk and Eş, 2017). In this context, it is necessary that the teachers who work/will work at the elementary school level should be the right role models in terms of perception towards science by the learners and guiding this perception. Because, knowledge, attitudes and values possessed by the learners towards science and scientists are influenced by the knowledge, attitudes and values of their teachers (Altınok, 2004; Palmer, 2001). At this point, being a role model is more important for the teachers — who will work with gifted students who are instinctively curious and motivated to study science and explore — to advance such students’ current performance further, to the level of enjoying science. It is essential that teachers whether they work with students who are diagnosed as gifted or not are educated as individuals who are open-minded, inquiry-minded, critical and creative, away from stereotypical thoughts. Therefore, it is necessary for the prospective teachers to directly take courses related to science (such as philosophy of science and history of science) during the undergraduate education. In addition, it is necessary to include critical, creative and evaluative thinking processes about how to distinguish scientific knowledge from pseudoscientific knowledge and how to obtain accurate and reliable scientific resources in the context of these courses. These contents should not only be in a theoretical structure, but also create practical environments where students can criticize scientific knowledge, its source and its presentation and give them opportunity to contemplate the subject and reflect it in the daily life. Teacher candidates must be confronted with the perception towards the scientists they possess and should be heading for thinking about this perception. They should be introduced to the right role models working in different areas of science and be shown that science is in fact very close, that it is not and cannot be isolated from society.

## Recommendations

The present study was carried out as a survey research to determine the perceptions towards scientists and science/pseudoscience distinctions of prospective teachers of gifted education and elementary education who are likely to be teaching to gifted students. It can be suggested for future studies that this study is supported by

interviews with teacher candidates in terms of both perception towards scientists and decisions regarding the science/pseudoscience distinction, with the hope that the interviews will further the present study.

## Acknowledgement

This study was supported by Scientific Research Projects Coordination Unit of Istanbul University with the project number of 25675.

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