Science Education International
31(3), 247-254
https://doi.org/10.33828/sei.v31.i3.3

ORIGINAL ARTICLE

An Investigation of Secondary School Students' Images of a Scientist with Regard to Gender Variable in Turkey

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ABSTRACT

The purpose of the current study was to determine secondary school students' images of a scientist with regard to gender as the variable. The study was carried out with the participation of 240 secondary school students in a city located in the western part of Turkey in the fall term of the 2017–2018 school year. The data were collected with modified-draw a scientist test. Within the context of the current study, the secondary school students' images of the scientist were explored in terms of appearance, working area, and work of the scientist. At the end of the study, it was determined that for these secondary school students their images of scientists' appearance (55.4%), workplace (82.1%), and studies (86.3%) were traditional. Considering the study results in terms of gender, it was noted that male students' images of a scientist's appearance were more traditional at 63.3%, while female images were less traditional at 44.6% and concentrated on the broader than traditional category (42.6%). Moreover, participant students' images about the scientists' workplace and studies did not reveal difference in terms of gender. Considering that the image of the scientist is shaped according to the gender, students must be offered opportunities to meet more woman scientists in course books, especially in science courses. In addition, visits should be organized to the workplace of scientists with different genders or more time should be allocated for scientific activities so students can have more true and reliable images of scientists' workplaces and studies.

KEY WORDS: draw a scientist test; gender; image; modified-draw a scientist test; scientist; secondary school students

INTRODUCTION

It is difficult to find a standard definition of science accepted by everybody as science is not stable and it constantly develops and changes (Bailin and Battersby, 2015). As science has influenced much of our views of technology, culture, economy, medicine, entertainment, and world both adversely or positively, it has made an important contribution to our understanding of the natural and social world (Matthews, 2017). We encounter the same difficulty experienced with the definition of science when investigating the definition of a scientist. While Yapıcı (2005) defined the scientist as someone who knows, classifies, accumulates, and interprets, he emphasized that the interpretation could only be realized by scientists. Some researchers focused on the qualities of the scientist instead of defining the scientist (Ortas, 2002; Soylu, 2004). In general, these qualities could be classified as curiosity, creativity, universality, ethics, and observation skills. However, it has been argued that if individuals understand the scientist, they can recognize science correctly and develop positive attitudes toward science (Kuhn, 2008).

LITERATURE REVIEW

Once individuals are born, they begin to familiarize themselves with the world around them and begin to learn various concepts. There are studies that reveal that an individual's perception of a scientist begins to be clarified during the pre-school period (Newton and Newton, 1992). Beginning with the pre-school period, the concept of scientist has been shaped by the individual's experiences. The number of studies that identify the individual's perceptions toward the scientist or images of the scientist has recently increased. Mead and Metraux (1957) carried one of the first studies about scientist with 35,000 students. Later, "Draw A Scientist Test – DAST" was developed by Chambers (1983) and seven qualities belonging to the scientist (i.e., lab coat-usually white, glasses, unkempt hair and scruffy beard, symbols of research, symbols of knowledge, technological tools and equipment-computer, microscope, telescope, titles like "I have found it") were revealed. Newton and Newton (1992) in their study investigated 4–11 year-olds' perceptions of the scientist using the DAST and tried to clarify ambiguities by asking questions to the participating children. They grouped the qualities of the scientist into two sub-titles: Figurative qualities (gender, lab coat, glasses, beard, and baldness) and background qualities (scientific knowledge and studies and being part of the scientific process). A few years later, Finson et al. (1995) designed the "Draw-a-Scientist Checklist/DAST-C," which enabled researchers to control the more common elements observed. When the literature is examined, there are many studies that reveal the individual's image of the scientist. These studies have taken into consideration variables such as grade level (Erkorkmaz, 2009; Kara, 2013; Togrol Yontar, 2013; Urtekin et al., 2013; Song and Kim, 1999), culture (Finson,

Science Education International
31(3), 247-254
https://doi.org/10.33828/sei.v31.i3.3

2001; 2003; Koren and Bar, 2009; Narayan et al., 2009), gender (Ruiz-Mallén and Escalas, 2012; Samaras et al., 2012), socioeconomic differences (Chambers, 1983), and where they live (Ruiz-Mallén and Escalas, 2012).

When the studies carried out using DAST were examined, it was considered that there would be more data from the drawings related to scientists as the DAST is limited to drawing a scientist. On the other hand, when the studies in literature were examined, it was found that the drawings included scientists' appearances, workplace, and the subject they studied. Taking all these points into consideration, different from the literature, modified-DAST (m-DAST), a modified version of DAST by Farland (2003), was used within the context of this study. Moreover, when the literature was examined, it was revealed that there were many factors that affect an individual's image of scientists (family, teachers, written and visual media, socioeconomic status, gender, class level, etc.). Within the context of this study, among these factors, gender was focused because there are studies in literature, which highlight that an individual's gender directly influences their image of scientists (Chambers, 1983; Nath and Thomas, 2013). In addition, different from the literature, this study discussed and examined the images of scientists in different categories of sensational, traditional, and broader than traditional.

METHODOLOGY

Data Collection Tool

This study's data were collected using the m-DAST. The m-DAST was designed in two parts. The first part consists of an illustration including the instruction and the second part consists of four open-ended questions. The m-DAST implemented with the participating secondary school students is presented below:

Imagine that tomorrow you are going on a trip (anywhere) to visit a scientist in a place where the scientist is working right now. Draw the scientist busy with the work this scientist does. Add a caption, which tells what this scientist might be saying to you about the work you are watching the scientist does. Do not draw yourself or your teacher.

I am a boy/girl;

Was the scientist you drew a man or woman?

Was the scientist you drew working outdoors or indoors?

What was the scientist doing in your picture?

(A blank space was left for students' illustrations.)

Two science teachers' opinions were taken to check whether the scale, which was adapted to Turkish by the researcher, served the purpose of the study, was clear, and was practical. Then, a pilot study was carried out with a secondary school student and to determine if the statements in the m-DAST were suitable for the target population of this study.

Population and Sample

The study was carried out in a city located in the western region of Turkey with secondary school students studying in a state school of middle socioeconomic level in the 2017–2018 academic years. Convenience sampling was used in the study as it was more practical in terms of timing. Table 1 presents the characteristics of the study group.

As indicated in Table 1, 240 secondary school students participated in the study. Of which 101 were female students and 139 were male. Moreover, 67 of them were studying in the 5th grade, 58 were 6th graders, 61 were 7th graders, and 54 were 8th graders. In Turkey, compulsory education begins at six. After a 4-year compulsory elementary school education, individuals continue with four more years of compulsory secondary school. Therefore, the participating students were aged between 10 and 13 years.

Data Analysis

The rubrics created by Farland (2003) for the analysis of data obtained from the m-DAST were used for this study's data analysis. The rubrics were classified into three titles (the appearance of the scientist, the working space of the scientist, and the subject of study of the scientist). Each student's illustrations were evaluated within the framework of these three titles and the categories were identified. The procedures to follow with rubrics are presented below.

The procedure to follow with the rubric about the appearance of the scientist: There were four categories related to the appearance of the scientist: Illustrations with no category, sensational illustrations, traditional illustrations, and illustrations broader than traditional category. If the illustrations were not included in any category, it was scored 0 points. In general, these students used a stickman figure or a figure that does not belong to a scientist (such as a student or a teacher). The illustrations in the sensational category were scored 1 point. The scientist in these illustrations may have a comic book appearance or a man or woman transformed into a monster. The illustrations in the traditional category were scored two points. The scientist in these illustrations was drawn as an ordinary white man. The illustrations evaluated in broader than traditional category were scored three points. The illustrations in this category were composed of a woman or a minority group scientist.

The procedure to follow with the rubric about the workplace of the scientist: There were four categories related to the workplace of the scientist: Illustrations with no category,

Table 1: The characteristics of the study group

Year level	Female	Male	Total
5th Grade	32	35	67
6th Grade	20	38	58
7th Grade	27	34	61
8th Grade	22	32	54
Total	101	139	240

Science Education International
31(3), 247-254
https://doi.org/10.33828/sei.v31.i3.3

sensational illustrations, traditional illustrations, and illustrations broader than traditional category. If the scientist's workplace was either vague or they involved a classroom environment, it was scored 0 points. The illustrations in the sensational category were scored 1 point. The workplace of the scientist in these illustrations could be a cave, a mysterious or a scary place, or a place filled with equipment that does not exist in a laboratory. The illustrations in the traditional category were scored two points. The workplace of the scientist in these illustrations was like a traditional laboratory setting. There were some tools like a table and a computer in these illustrations. The illustrations evaluated in broader than traditional category were scored three points. The illustrations in this category were different from the illustrations in a traditional laboratory setting and involved different structures than traditional laboratory equipment of any kind.

The procedure to follow with the rubric about the subject of study of the scientist: There were four categories related to the study field of the scientist: Illustrations with no category, sensational illustrations, traditional illustrations, and illustrations broader than traditional category. If the scientist's subject was not very clear, it was scored 0 points. The illustrations in the sensational category were scored one point. The subject of the scientist in these illustrations was scary activities that were carried out with equipment of any kind that does not exist in a normal laboratory. The illustrations in the traditional category were scored two points. The studies of the scientist in these illustrations were the ones that could be accepted as real by the students. However, it was impossible for these subjects to actualize in everyday life. The illustrations in this category involved statements like "the scientist is working on …" or "the scientist is trying to actualize …". Nevertheless, the student did not clearly explain the procedures the scientist followed or how he actualized his study. The illustrations evaluated in broader than traditional category were scored three points. The illustrations in this category revealed the scientist doing more realistic work. Moreover, the students were expected to explain the study with its all dimensions.

The data obtained from the data collection tool were evaluated according to the rubrics given above and then categories were formed. After that, these data were entered into the SPSS program and the secondary school students' images of the scientist according to the gender were compared.

FINDINGS AND DISCUSSION

The findings obtained from the study carried out to determine the secondary school students' images of the scientist according to the gender are presented in Tables 2-4. The students in the given examples were coded with numbers. In coding, "S" represents a student and the number represents the ranking. For example, S100 is the 100th student.

Table 2: The secondary school students' images of the appearance of the scientist according to their gender

	The images of the appearance of the scientist									
Students	**Illustration with no category**		**Sensational appearance**		**Traditional appearance**		**Broader than traditional appearance**		**Total**	
	f	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**
Female student	2	2	11	10.9	45	44.6	43	42.6	101	100
Male student	9	6.5	31	22.3	88	63.3	11	7.9	139	100
Total	11	4.6	42	17.5	133	55.4	54	22.5	240	100

Table 3: The secondary school students' images of the scientist's workplace in terms of their genders

	Images of the scientist's work areas							
Students	**Illustration with no category**		**Sensational appearance**		**Traditional appearance**		**Total**	
	f	**%**	**f**	**%**	**f**	**%**	**f**	**%**
Female student	2	2	17	16.8	82	81.2	101	100
Male student	0	0	24	17.3	115	82.7	139	100
Total	2	0.8	41	17.1	197	82.1	240	100

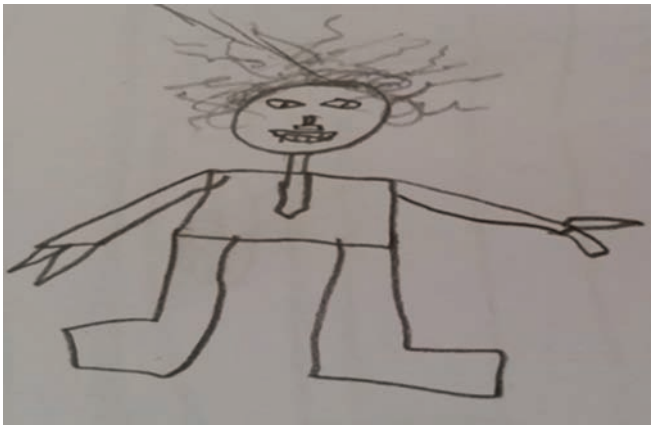
Table 4: The secondary school students' images of the scientist's subject of study in terms of their genders

	Images of the scientist's subject of study							
Students	**Illustration with no category**		**Sensational appearance**		**Traditional appearance**		**Total**	
	f	**%**	**f**	**%**	**f**	**%**	**f**	**%**
Female student	2	2	12	11.9	87	86.1	101	100
Male student	1	0.7	18	12.9	120	86.3	139	100
Total	3	1.3	30	12.5	207	86.3	240	100

Science Education International
31(3), 247-254
https://doi.org/10.33828/sei.v31.i3.3

The relationship between the secondary school students' gender and the images of the appearance of the scientist is presented in Table 2.

When Table 2 is examined, it was found that of 240 secondary school students, 4.6% (11 students) of their drawings were evaluated as illustrations with no category and the students drew stickman (cinali) figures in this category. It was noted that the scientist had a sensational appearance in the illustrations by 10.9% of the female students and 22.3% of the male students participating in the study. It was seen that the students expressed the scientist as a weird person with spiky hair and as a bad or dehumanized person in the illustrations evaluated in sensational category. The representative examples of this category are presented below.



S68: "The illustration in the example belongs to a male student in the 6th grade. The student explained that he drew a male scientist. As seen the illustration, the scientist looks bad and frightening with unkempt hair."

As evidenced in Table 2, the scientist had a traditional appearance in 55.4% (133 students) of illustrations. In this category, there were 44.6% of them female students and 63.3% of them male students. Illustrations evaluated as a traditional appearance included a white man with no hair and wearing glasses. An example of this category is presented below.

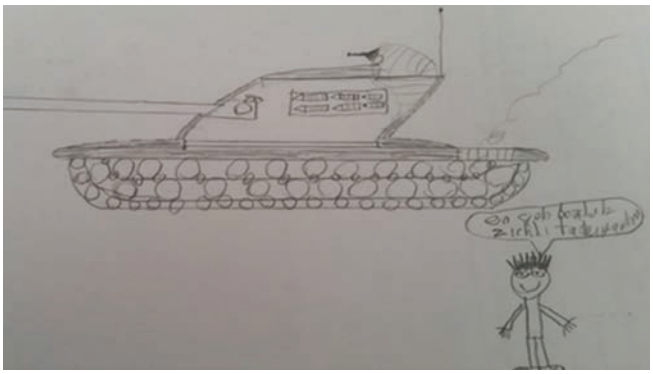
S72: "The illustration in the example belongs to a male student in the 6th grade. The student stated that he drew a male scientist working indoors. As seen in the illustration, the scientist looks optimistic, he is bald and wearing glasses and a lab coat."

From Table 2, 22.5% (54) of the 240 students included a scientist with a more broad appearance rather than the traditional appearance. Of these students, 42.6% were female students and 7.9% were male. The illustrations evaluated as a broader appearance than a traditional included an illustration of a woman or a minority group. An example of this category is presented below.

S150: "The illustration in the example belongs to a female student in the 7th grade. As seen in the illustration, the student drew a female scientist. The scientist in the illustration is wearing glasses and a lab coat."

The relationship between the secondary school students' genders and the images of the scientist in terms of their workplace is presented in Table 3.

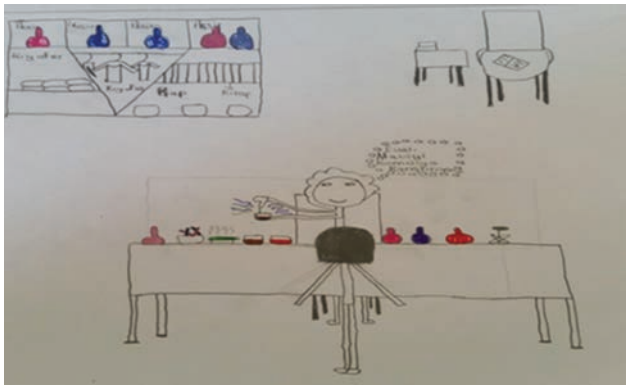
When Table 3 is examined, it was found that the illustrations of two students were in the illustrations with no category. Furthermore, it was determined that the scientist's workplace was considered sensational by 17.1% of students (41 students). About 16.8% of the female students and 17.3% of the male students were in this category. This category included settings different from the ordinary laboratory such as a cave, dark, or scary place. Moreover, these illustrations included frightening laboratory equipment that would not normally be found in a laboratory setting. An example belonging to the illustrations evaluated in this category is presented below.



Science Education International
31(3), 247-254
https://doi.org/10.33828/sei.v31.i3.3

S230: "The illustration in the example belongs to a male student in the 8th grade. The student explained that he drew a tank having hollows and added that thanks to these hollows, he would save himself from the bullets."

Of the school students participating in the study, 82.1% of them (197 students) had traditional images of the scientist' workplace. About 81.2% of the female students and 82.7% of the male students were included in this category. Considering the illustrations evaluated in this category, it was found that the students drew a traditional laboratory setting, the cupboards were usually full of books or experiment materials and in the lab, there was a table with a computer, microscope, or experiment materials on it. An example belonging to the illustrations evaluated in this category is presented below.



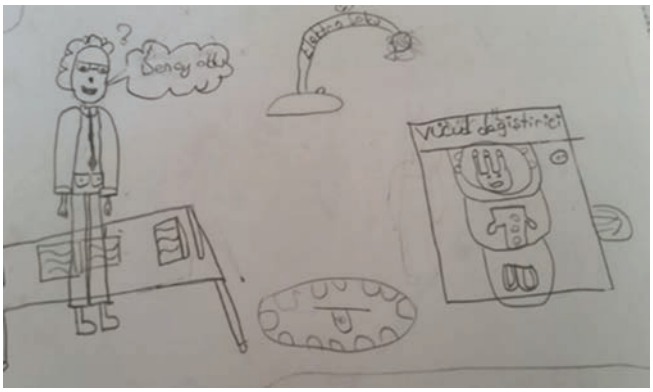
S30: "The illustration in the example belongs to a female student in the 5thgrade. In the illustration there is a traditional laboratory setting, a cupboard, and a study table. Moreover, there are books, containers, bottles, and extra clothes. There are experiment materials on the scientist's study table."

The secondary school students' images of a scientist's subject of study in term of their genders are presented in Table 4.

As seen in Table 4, three students were evaluated to have an illustration with no category. About 12.5% of them (30 students) drew sensational illustrations of the scientist's studies. About 11.9% of the female students and 12.9% of the male students were included in this category. There were scary activities involved in the sensational drawings that would be considered impossibility in a normal laboratory setting. A representative example of this category is presented below.

S42: "The illustration in the example belongs to a male student in the 5th grade. As seen in the illustration, the scientists carry out a study about an alien egg. However, there are people with a gun in their hands."

When Table 4 was examined, 86.3% of them (207 students) made traditional illustrations about the scientists. About 86.1% of the female students and 86.3% of the male students were included in this category. Considering the illustrations evaluated in this category, there were some subjects of study, which were considered true by the students. In this category, the students did not explain the studies of the scientist in enough detail and used generalized statements like "the scientist studies on …" An example belonging to the illustrations evaluated in this category is presented below.



S81: "The illustration in the example belongs to a female student in the 6th grade. The scientist working in a laboratory setting made a body converter. However, the students who drew it did not explain the processing of this operation. In addition, it is revealed that the student reflected an idea in his illustrations which is impossible to be actualized."

CONCLUSION

This study aimed to determine the secondary school students' images of the scientist. It also sought to discuss the students' images of the scientist regarding their genders. Within the context of the study, the secondary school students' images of the scientist were examined under three different titles: appearance, workplace, and field of study.

As a result of the study, it could be stated that the participating secondary school students' images of the scientist were traditional (Table 2). More than half of the students (55.4%) participating in the study were evaluated as using a traditional appearance. When the students evaluated in the traditional category were considered in terms of gender, it was noted that more male students were included in this traditional category (Table 2). In fact, 63.3% of the male students participating in the study were evaluated in this category. This result is compatible with many studies in literature. Ocal (2007) in his study concluded that the students' perceptions of the scientists were traditional, and the scientist had the following qualities such as wearing a lab coat, devoting himself to his work, bald,

Science Education International
31(3), 247-254
https://doi.org/10.33828/sei.v31.i3.3

and male individuals. Barman et al. (1997), Finson (2003), Kılıc (2010), Muslu and Akgul (2006), Sahin (2009), and Yvonne (2002) in their studies determined that the students could go beyond the traditional illustrations. This result could be interpreted that the perception of scientist as a male has been embedded for years. In addition, it can be an indicator that science is a field that has been predominantly a male profession.

It was noted that the number of the images in the sensational and broader than traditional category was almost equal in number (Table 2). The scientists in the sensational category were illustrated as weird, having spiky or unkempt hair, and bad or dehumanized. About 22.3% of the male students participating in the study were evaluated in the sensational category. This result is compatible with the study results carried out by Bang et al. (2014) with Korean high school students. Bang et al. (2014) concluded that satanic and magician types were included in some high school students' perceptions of the scientist. There were more male students in this category. This could be the result of more male students encountering such types in the films or cartoons they are more likely to watch on television.

The scientist was drawn as a woman in the illustrations evaluated in the broader than traditional category. While 42.6% of the female students participating in the study were included in this category, only 7.9% of the participating male students were in this category (Table 2). The female students in their illustrations of the female scientist stated that they "depicted" Madame Curie. The female students' illustrations of female scientist were compatible with many studies in the literature (Aggül Yalcın, 2012; Fort and Vanny, 1989; Kara, 2013; Kibar, 2008; Mead and Metraux, 1957; Song and Kim, 1999; Togrol Yontar, 2000). Kibar (2008) concluded in his study that the woman scientist was mostly drawn by female students. Mead and Metraux (1957) in their study concluded that the female students mostly drew woman scientists and the male students mostly illustrated male scientists. Similarly, Moaldomhnaigh and Hunt (1988) in their study determined that female students emphasized "woman scientist" more than the male students. This can be interpreted that while individuals form their image of a scientist, they are under the influence of their own genders (Bag, 2013).

As a result of the study, it can be stated that secondary school students' images of the scientist's workplace were traditional (Table 3). It was determined that these secondary school students produced illustrations about the scientist's workplace in the sensational and traditional categories. Only 41 students thought that the scientist's workplace was sensational. About 17.3% of the male students (24 students) and 16.8% of the female students (17 students) participating in the study were evaluated with illustrations as sensational. The number of students who thought that the scientist's workplace was traditional was predominate (Table 3). It was noted that 82.1% (197 students) of those participating in the study were evaluated in the traditional category. This comprised 82.7% of the male students and 81.2% of the female students.

Considering the illustrations evaluated in the traditional category, the workplace was generally drawn as indoors and in a laboratory. The structures frequently encountered in students' illustrations were study table, cupboards filled with glass tubes and bottles, bookcases, and experiment materials. A similar result was revealed in the study carried out by Chambers (1983) and it was interpreted that students had the idea, "scientist do experiments in a laboratory." A similar result was revealed in the study carried out by Korkmaz and Kavak (2010). Korkmaz and Kavak (2010) in their study revealed that both male and female students thought that the scientist's workplace was an indoor laboratory. In the study carried out by Kibar (2008), it was determined that the students in the 4th, 5th, 6th, 7th, and 8th grade in their illustrations about the scientist's workplace included research symbols such as a glass tube and flask and also the scientist worked in the laboratory and used books as the symbol of knowledge. The reason why students' images of a scientist's workplace was included mostly in the traditional category is that the scientists are most often shown working indoors in a laboratory in written and visual media and in textbooks.

As a result of the study, it can be stated that secondary school students' images of the scientist's workplace is traditional (Table 4). Of 240 students participating in the study, 207 of them included traditional illustrations in their drawings while 30 of them included sensational drawings. When the results were considered in terms of gender, it was revealed that both male and female students mostly made traditional illustrations. About 11.9% of the responses of the female students and 12.9% of the male students were evaluated in the sensational category. The sensational illustrations depict the scientists mostly dealing with dangerous and secret missions. This result concurs with Turkmen (2008). In the study carried out by Reis and Galvão (2007), the students studying in the 11th grade were asked to write a science-fiction story and then interviews were carried out. It drew attention that many of the students' science-fiction stories had disaster scenarios. About 86.1% of the responses of the female students and 86.3% of the male students were evaluated in the traditional category. The students who had illustrations in the traditional category used statements like "The scientist produces …/The scientist does …;" however, they did not explain how this process was realized. The illustrations evaluated in the traditional category reveal that there are studies carried out which were impossible to perform in a traditional laboratory environment (body converter, reduction potion, the operation of growing prodigiously, and potion of passing the exams easily). Guler and Akman (2006) in their study carried out with the pre-school children asked the question "What does a scientist do?" and 11.2% of the students participating in that study included experiments, potions, and mixtures in their statements. This result can be considered as the students' perceptions of the answers to the questions such as "What does science do?" "What does a scientist do?"

When the literature is examined, there are studies, which reveal that an individual's perception of the scientist started

to be shaped during the pre-school period. Guler and Akman (2006) in their study revealed that pre-school students had traditional perceptions of the scientist. Moreover, studies have revealed that there were many factors having an effect on the individuals' images of the scientist. These factors can be listed as follows: Gender, media, family, culture, teacher, peer groups, scientific activities the individuals join, etc. Song and Kim (1999) in their study investigated the sources of the students' images of the scientist and concluded that media, family, teacher, and peers had an effect on students' images. Ambusaidi et al. (2015) revealed a similar result. Ambusaidi et al. (2015) concluded that media, course books, and the internet had an effect on the students' images of the scientist. Reis and Galvão (2007) in their study carried out using semi-structured interviews with students concluded that film and cartoon characters affected students. Moreover, there are studies, which exhibit that scientists who were invited to the schools changed the students' images of the scientist (Bodzin and Gehringer, 2001; Flick, 1990). In addition, there are studies in literature that reveal that families' educational background and occupations had positive or negative effects on individual images of a scientist (Kibar, 2008; Ocal, 2007). The study carried out by Dilli et al. (2016) concluded that parents' depictions of a scientist were similar to those illustrated by the children. This condition suggests that the family atmosphere where the individuals grow up has an effect on the formation of their images of a scientist.

Considering all these points, it can be stated that because an individual's perception of the scientist begins to occur at a very early age, the image of scientists used in the structures such as films, cartoons, and computer games must be paid attention to and more images of woman scientist must be included in these structures. Considering that the image of the scientist is shaped according to the gender, which is one of the results of this study, students must be offered opportunities to see more woman scientists in course books, especially in science courses, and media. In addition, visits should be organized to the workplace of scientists with different genders or more time should be allocated for scientific activities so students can have more true and reliable images of the scientist's workplace and studies.

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