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The perceptions of Turkish students against scientists and the emotions of scientists in the post-pandemic

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ABSTRACT

Today's students are expected to think like scientists. Every student has a different life and they learn in different ways. We need to understand how students view scientists and what their perceptions of them are in order to make these expectations a reality. This study aims to investigate the perceptions that Turkish secondary school students have of scientists and show how these perceptions have changed in the wake of the pandemic particularly with regard to the emotions of scientists. This research is survey research. The Draw a Scientist Test Checklist (DAST-C) was used as the data collection and analysis tool for the research. In the emotion dimension of this study, emotions in the Plutchik Emotion Model were based on the data collection tool. Descriptive statistics were used to analyse the data. Students' perceptions of scientists in this study show a fall in the rates of the standards that constitute the stereotypical image. In the findings of the study, it was seen that the scientist was generally young and female. This shows that recent developments have changed students' perceptions. It is clearly seen that the pandemic has changed the minds of scientists and students.

Contribution/ Originality: This research aimed to reveal the perception of scientists among secondary school students. In the relevant literature, there are studies on the perceptions of Western students. Therefore, this research was conducted with Turkish students. In addition, it focused on how the pandemic affected students' perceptions of scientists.

1. INTRODUCTION

One of the main goals of science teaching is to turn out students who can find solutions to the problems they face in daily life from a scientific perspective. Science contains all the beliefs and values necessary for the advancement of knowledge. Early exposure to science instills a spirit of discovery in students who exhibit curiosity, excitement and interest in scientific subjects throughout their academic careers (Akman, Ustün, & Güler, 2003; Crowther, Lederman, & Lederman, 2005). One of the main tasks of teachers in contemporary science teaching is to create a learning environment in which students actively participate and learn by doing and experiencing. Students must work like scientists while employing their knowledge of the scientific method. Students develop scientific thinking skills when they participate in research, ask questions, form hypotheses, make observations and conduct analyses (Lannes, Flavoni, & De Meis, 1998). A learner does not only develop this perception through academic instruction. Real-world experiences also play a very influential role. There are various ways to interact with scientists in the visual and verbal media that students frequently use mainly in textbooks, TV shows, movies and cartoons. Many features of scientists are presented in the media and mass media in a way that supports a certain

image. Students exposed to all these stimuli form their own images of scientists that may be resistant to change as a result of formal and informal learning (Türkmen, 2008).

How to change the students' perception of scientists is a problem that has to be addressed. The first studies made on this subject state that students have difficulty describing the image in their minds. This is why the "Draw A Scientist Test" (DAST) was developed by Chambers (1983) using a sample of 4,807 people. This particular study spans 11 years from 1966 to 1977. The test is considered useful for exploring how students perceive scientists because it provides symbolic indicators of students' basic beliefs. The figures that make up these standards include symbolize technology, scientific research, scientists' working conditions and the physical and psychological characteristics of scientists. Figures representing knowledge are white coats worn in laboratories, pens placed in the pockets of these coats, eyeglasses and hand-held notebooks. Disorganized and complex working environments take the form of figures showing that scientific research is being carried out. These working environments are usually indoor spaces particularly laboratories. Famous quotes by scientists and incomprehensible formulas are prominent in these places.

The figures representing technology take the form of computers, microscopes and telescopes. Drawings of scientists typically feature old men with beards and wild hair (Chambers, 1983; Guler & Akman, 2006). When we examine the research done to determine the perception that students have of scientists, we observe that their findings are consistent with each other. The image of the scientist also has an emotional aspect. According to studies on the emotional element, students perceive scientists to be unfriendly when working which demonstrates that students do not voluntarily provide information about scientists' feelings and emotional changes. Similarly, these studies report that students see scientists as objective, bound by rules and unaffected by culture and the social environment (Chambers, 1983).

The depiction of scientists is regarded as similar to the image that the media portrays of scientists. The scientist portrayed in the media is usually depicted as having an unusual physical appearance, being emotionally less happy than other people, working in dark, complex and gloomy laboratory environments, poring over books filled with complex formulas or handling laboratory equipment such as test tubes and beakers of various sizes (Guler & Akman, 2006). The media's depiction of scientists changed when the COVID-19 pandemic broke out in 2020. Students were exposed to the explanations and suggestions of numerous scientists who specialize in this field during the pandemic just like other people. They did not look different as mentioned. They were people striving to benefit mankind and they explained the work. This indicates that the epidemic may be a factor in how students perceive scientists.

A review of the literature showed that the studies investigating the image of the scientist and using DAST usually come from Western countries. Very little non-Western research has looked at how people perceive scientists. Similar findings are reported by studies conducted in different countries about the perception of scientists.

For instance, Takach and Tobi (2021) claim that the cultural make-up has an impact on how people perceive scientists in their research with Omani and Lebanese teachers and students. Similarly, Rubin's study demonstrates that the cultural perceptions of Israeli teachers who speak Arabic and Hebrew differ. Western scientists were shown in the figures of scientists in both studies despite the fact that the sample group was not from Western culture. Research is needed to describe in detail the perceptions of scientists held by Turkish students. In addition, there are no studies investigating how the pandemic affected the image of scientists. This study aims to examine the image of scientists held by Turkish secondary school students and reveal how this image changed after the pandemic particularly with respect to scientists' emotions to come up with suggestions as to how to close this gap identified in the literature.

2. METHODOLOGY

2.1. Research Design

This study is a survey. The purpose of survey research is to reveal and describe the opinions of a large sample group regarding a specific topic (Cohen, Manion, & Morrison, 2007) to identify and describe how secondary school children perceived a scientist.

2.2. Study Group

The study group consists of 413 (213 girls and 200 boys) Turkish students with low socioeconomic backgrounds studying in 14 branches in four secondary schools.

The convenience sampling method was used to select the study group. Convenience sampling is remarkable in that it selects the most easily accessible people for the study group (Yıldırım & Şimşek, 2016).

2.3. Data Collection Tool

The students who formed the study group were asked to draw a picture of a scientist, briefly describe what the scientist was doing and explain what the scientist was feeling while working. The Draw a Scientist Test Checklist (DAST-C) was used as the data collection and analysis tool for this study. A DAST-C was developed by Finson, Beaver, and Cramond (1995) based on seven standards that describe the image of a scientist as put forward by Chambers (1983). It also reveals other possible standards and unpredictable alternatives in addition to these standards (Finson, 2003). The DAST-C used in this study has 14 standards. These standards are listed in Table 1. Analyzing emotions is both a difficult and complex process, so the emotions in the Plutchik Emotion Model were used as the basis for the data collection tool in the emotional aspect of this study. This model provides a roadmap for making and explaining emotions. Robert Plutchik mentions eight basic emotions in his model (Anderson, 2017). The emotions of the scientist who was asked to grade the students and who was mentioned in the Plutchik Emotion Model are also listed in the table below.

Table 1. DAST-C standards and scientist emotions.

No.	DAST-C standards	No.	Scientist emotions
1	Lab coast	1	Joy
2	Eyeglasses	2	Trust
3	Facial hair	3	Fear
4	Symbols of research	4	Surprise
5	Symbols of knowledge	5	Sadness
6	Symbols of technology	6	Disgust
7	Relevant captions	7	Anger
8	Male gender only	8	Anticipation
9	Middle age scientist	9	Other
10	Caucasian only		
11	Mythic stereotypes		
12	Indications of secrecy		
13	Scientist working indoors		
14	Indications of danger		

2.4. Data Analysis

Descriptive statistics were used to analyze the data. Scientists' drawings that matched DAST-C standards received a score of 1 while those that did not received a score of 0. Moreover, these data were explained in terms of frequency (f) and percentage (%). The data were supported by the students' drawings.

3. FINDINGS

This heading has two subheadings: "findings for DAST-C" and "findings for scientists' emotions."

3.1. Findings for DAST-C

Of the 413 secondary school students who made up the study group, 213 (51.57%) were women and 200 (48.43%) were men. The following data was obtained when we analyzed the drawings of scientists made by 413 students based on the 14 standards for a scientist's image according to DAST-C.

Table 2. Frequency values of the analysis of the drawings of students for the DAST-C standards.

		Students who draw		Students who don't draw	
		Female students	Male students	Female students	Male students
		F	F	F	F
Lab coast		55	18	158	182
Eyeglasses	Female scientist with eyeglasses	15	3	-	-
	Male scientist with eyeglasses	19	40	-	-
	Total	34	43	179	157
Facial hair		45	100	168	100
Symbols of research		131	136	82	64
Symbols of knowledge		106	122	107	78
Symbols of technology		117	133	96	67
Relevant captions		90	81	123	119
Male gender only	Male	103	180	-	-
	Female	109	20	-	-
	Total	212	200	1	0
Young-middle age		166	166	47	34
Caucasian only	White	205	200	-	-
	Black	4	0	-	-
	Total	209	200	4	0
Mythic stereotypes		5	20	208	180
Indications of secrecy		7	14	206	186
Scientist working indoors	In-door	76	139	-	-
	Out-door	137	61	-	-
	Total	213	200	0	0
Indications of danger		8	31	205	169
Wearing a mask		45	33	168	167

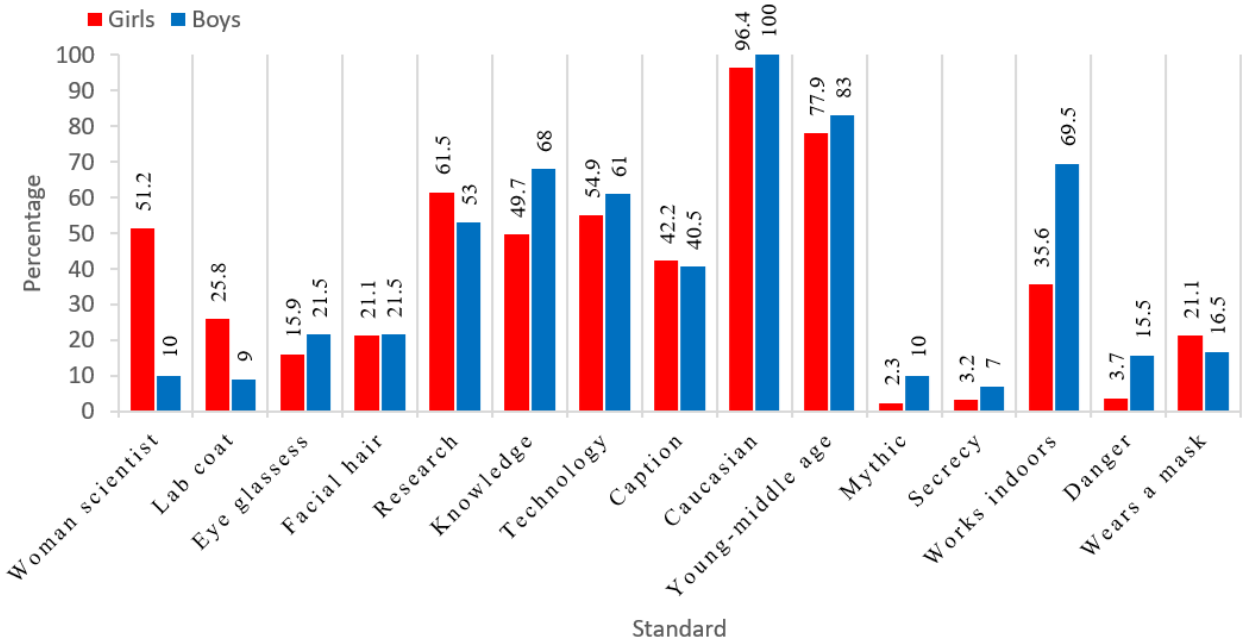

Figure 1. Percentage values for the analysis of students' drawings based on DAST-C standards.

According to Table 2 and Figure 1, the proportion of stereotypical images of scientists held by the 413 students in the study group is falling.

Lab coats: Female students' paintings of scientists show a prevalence of lab coats of 25.8% while male students' drawings show a prevalence of 9%.

Glasses: The results show that 15.9% of female students drew scientists with glasses. This rate was 21.5% for male students.

Facial Hair: 21.1% of female students and 21.5% of male students drew scientists with moustaches, beards or both.

Symbols of Research: The analysis of the students' drawings revealed the perception that scientists work hard and are constantly researching and reading. The perception that technology makes research easier was also noted. 61.5% of the drawings made by female students showed scientists conducting research while male students showed 53.0%.

Symbols of Knowledge: Elements representing knowledge were found in 49.7% of the female students' drawings and 68.0% of the male students' drawings.

Technology: Elements representing technology were in 54.9% of the drawing made by female students and in 61.0% of the drawings made by male students.

Gender: Analysis of the subject of the drawings by gender showed that 51.2% of the female students and 10% of the male students drew women scientists. Unlike the results seen in the related literature, the findings of this study showed that female students' perceptions of women scientists were not limited to Marie Curie. Many imagined themselves as women scientists and depicted this in their drawings. Examples of students' drawings of scientists are shown in Figure 2.

Figure 2. Example of a scientist from student drawings (drawing by a female student who draws herself as a scientist and Einstein).

We carefully examined the students' drawings to identify the scientists they represented. These data are summarized below.

Table 3. Frequency values for the scientists drawn by male and female students.

	Female students	Male students
	F	F
Himself /Herself	60	25
No-name	57	97
Famous scientist	50	47
Aziz Sancar	21	14
Uğur Şahin	15	9
Ancient Turkish scientists	10	8

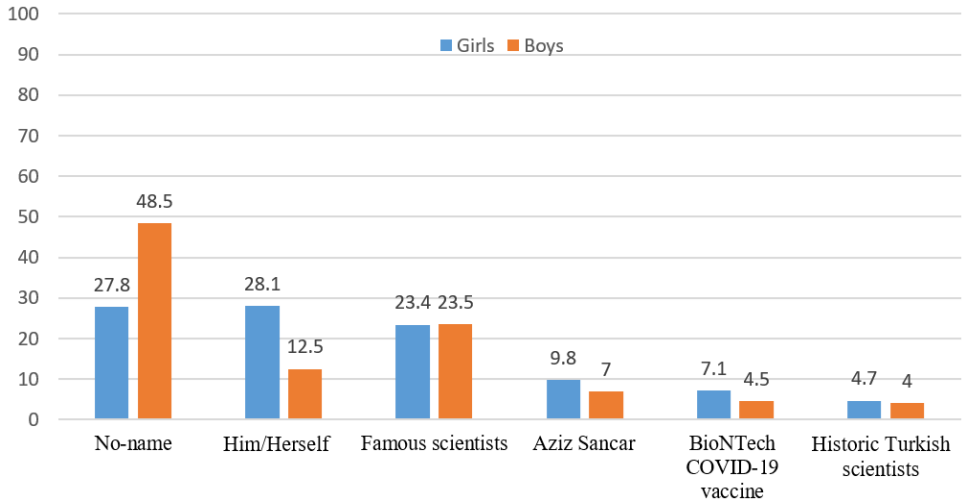

Figure 3. Percentage for specific identities of the scientists drawn by male and female students.

The results of Table 3 and Figure 3 show that 27.8% of the female students and 48.5% of the male students did not specify the names of the scientists they drew. Analysis of these drawings found that 28.1% of the female students drew themselves and 23.4% drew famous scientists such as Einstein, Newton, Bell and Edison. 9.8% drew Nobel Prize-winning Turkish scientist Aziz Sancar, 7.1% drew Turkish scientist Uğur Şahin who discovered the BionTech vaccine which offers hope for the COVID-19 pandemic and 4.7% drew old Turkish scientists such as Ali Kuşçu. Male students drew themselves (12.5%), famous scientists (23.5%), Aziz Sancar (7.0%), Uğur Şahin (4.5%) and old Turkish scientists (4.0%). These examples are given in Figures 4 and 5.

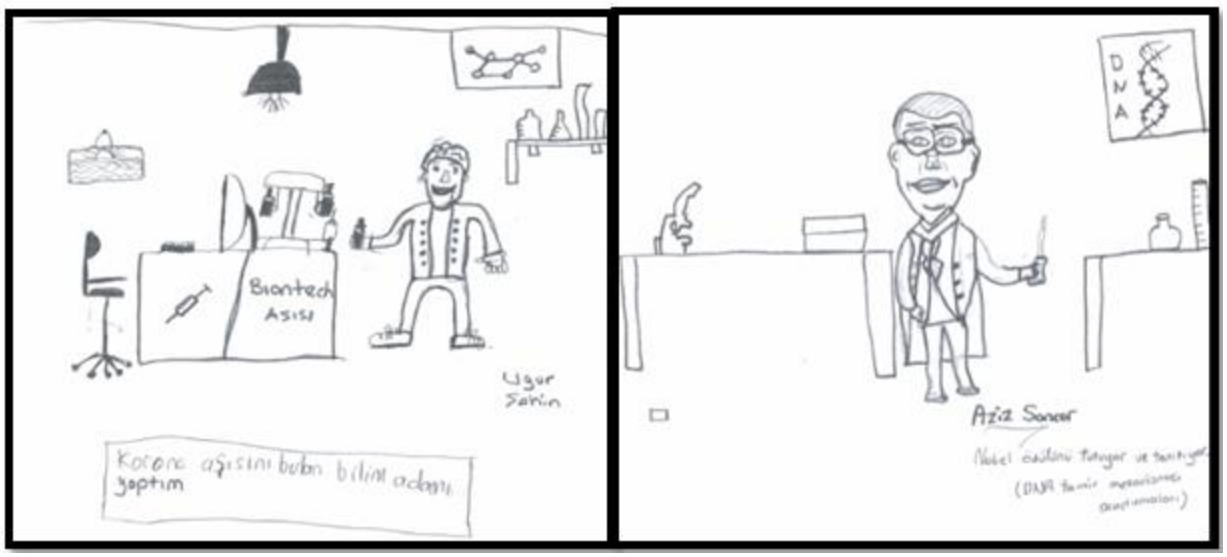

Figure 4. Example of Uğur Şahin and Aziz Sancar from student drawings.

Relevant caption: Drawings of complex formulas and taxonomies scored similarly for male and female students at 42.2% for female students and 40.5% for male students respectively. Caucasian Only: Analysis of the race of the depicted scientists showed them to be overwhelmingly Caucasian (96.4% for female students and 100.0% for male students). Only four of the female students' drawings of black scientists were different. The documentary Wormhole with famous actor Morgan Freeman and famous astrophysicist Neil deGrasse Tyson who makes frequent television appearances and is known for the documentary Cosmos: A Spacetime Odyssey in which he tries to present science in a humorous way forms the basis for these few drawings (see Figure 5). Middle-aged or old Scientist: Interestingly, young scientists are represented well in the drawings made by both female (77.9%) and male (83.0%) students.

Figure 5. Examples of Neil deGrasse Tyson and Ali Kuşçu from student drawings.

Mythical stereotype: According to the analysis of the data, this standard was present in 10.0% of male drawing and 2.3% of female drawing. This indicates a decrease in the perception that scientists' efforts in old cartoons or horror films are dangerous or can create super creatures. Indications of secrecy: According to the analysis data, this standard was present in 3.2% of the female students' drawings and 7.0% of the male students' drawings. Indications of danger: The rate for this standard was much higher in the male students' drawings than in the female students' drawings (3.7% of the female students' drawings and 15.5% of the male students' drawings).

Scientists working indoors: When the working environment of the scientists was examined, it was discovered that 35.6% of the female students' drawings and 69.5% of the male students' drawings depicted scientists working indoors. Male formal and indoor settings such as laboratories were seen in the drawings made by the male students while female students preferred to draw the more informal and open working environment of the scientist outdoors. Outdoor research environments are often depicted in student drawings as astronomy-based observations of the sky and biology-based observations of plant species in their natural habitats. Furthermore, drawings of Newton sitting under an apple tree are seen as one of the most accurate examples of science taking place outdoors. These drawing examples are shown in Figure 6.

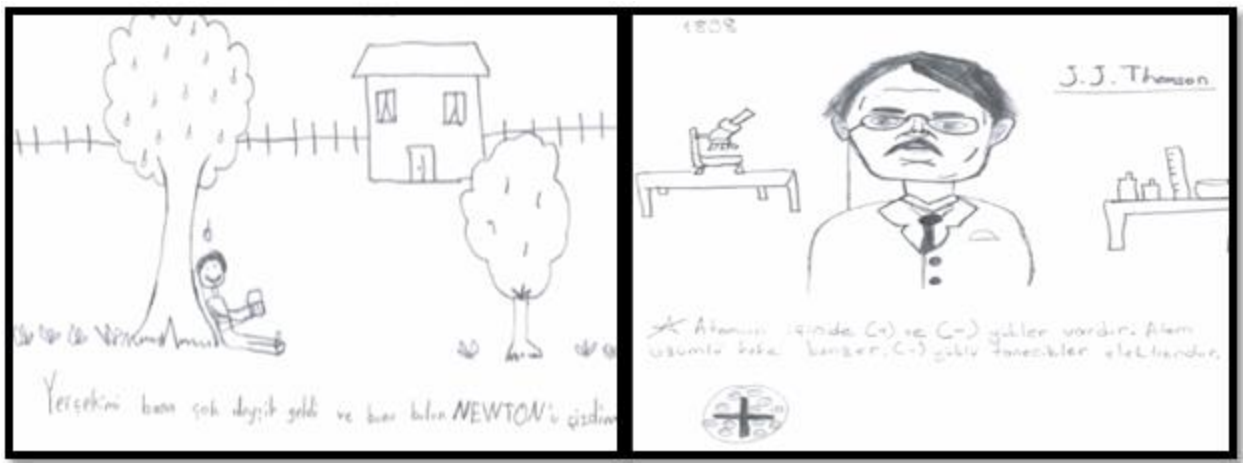

Figure 6. Examples of indoor and outdoor settings from student drawings (Newton and Thompson, respectively).

Although not covered by the 14 DAST-C standards, the scientists depicted in this study wore surgical masks in 21.1% of the drawings made by female students and 16.5% of the drawings made by male students because of the impact of the pandemic on social life. These drawing examples are shown in Figure 7.

Figure 7. Example of scientists wearing surgical masks from student drawings.

3.2. Findings for Scientists' Emotions

The Plutchik emotion model forms the basis for the findings of the scientists' emotional aspect of the study. Plutchik's model states that human emotions can be explained by eight basic emotions. These emotions can be classified as primary emotions grouped in four pairs. This information is shown in Table 4 to make the findings more understandable.

Table 4. Plutchik emotion model.

Basic emotion	Emotional opposite
Joy	Sadness
Trust	Disgust
Fear	Anger
Surprise	Anticipation

Table 5 and Figure 8 show the information about the scientists drawn from 213 female and 200 male students in the study group.

Table 5. Frequency values for the emotions of scientists drawn by female and male students.

	Female students	Male students
	F	F
Joy	128	98
Anticipation	89	66
Trust	44	24
Sadness	40	21
Anger	21	33
Disgust	14	26
Fear	0	0
Suprise	0	0

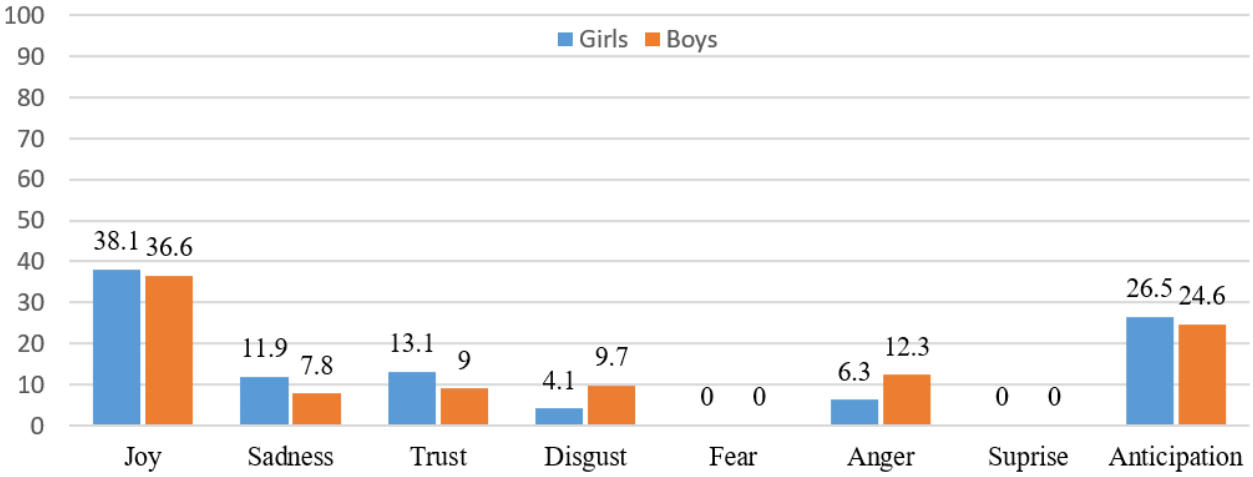

Figure 8. Percentage for the emotions of the scientists drawn by male and female students.

Analysis of the emotion aspect of the students' drawings showed that 36.6% of the male students and 38.1% of the female students' emphasized joy while 24.6% of the male and 26.5% of the female students emphasized anticipation. 9% of the male students' drawings and 13.1% of the female students' drawings promote trust in scientists. Furthermore, 7.8% of the male students and 11.9% of the female students drew the scientists feeling sad. Anger is depicted in 12.3% of the male students' drawings and 6.3% of the female students' drawings. Hatred is one of the least depicted emotions. This feeling is depicted in 9.7% of the drawings made by male students and 4.1% of the drawings made by female students. The emotions of surprise and fear were not depicted in any drawing in this study. These drawing are presented in Figure 9.

Figure 9. Example of joy and sadness from the student's drawings.

There are several situations where students have depicted multiple emotions in their artwork. The Plutchik emotion model explains the presence of more than one emotion in the context of human emotions. The findings were also assessed in terms of human emotions to provide a more in-depth perspective on the emotional aspect of the study. Human feelings in the Plutchik emotion model are presented in Table 6.

Table 6. Human feelings in the Plutchik emotion model.

Human feelings	Emotions	Opposite
Optimism	Anticipation + Joy	Disapproval
Love	Joy + Trust	Remorse
Remorse	Sadness + Disgust	Love
Aggressiveness	Anger + Anticipation	Awe

Table 7 and Figure 10 show the information about the feelings of the scientists drawn by the 213 female and 200 male students in the study group.

Table 7. Frequency values for the feelings of scientists drawn from female and male students.

	Female students	Male students
	F	F
Optimism (Anticipation and joy)	80	66
Love (Joy and trust)	44	24
Aggressiveness (Anger and anticipation)	21	33
Remorse (Sadness and disgust)	14	21

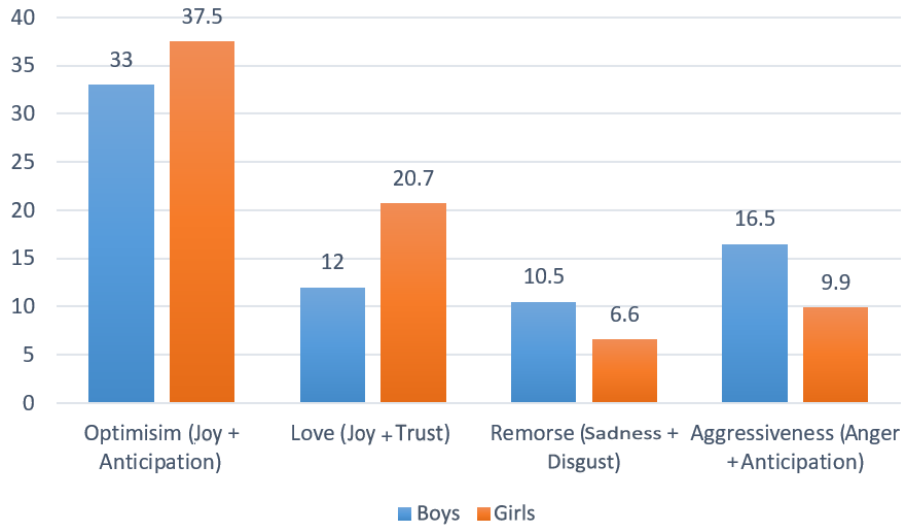

Figure 10. Percentage for the feelings of the scientists drawn by male and female students.

Examination of the students' drawings shows that scientists represent optimism in 37.5% of female students' drawings and 33.0% of male students' drawings. Love, a combination of joy and trust is found in 20.7% of the female students' drawings and 12.0% of the male students' drawings. Traces of sadness and hate are present in 6.6% of the female students' drawings and 10.5% of the male students' drawings. The rate of aggression was 9.9% in the female students' drawings and 16.5% in the male students' drawings.

4. DISCUSSION AND CONCLUSION

Students are required to address real-world issues from a scientific viewpoint as an essential component of modern science education. It will be easier to develop teaching materials for science when it is known how students view science and scientists. The perception of the scientist in students' thoughts will also be a sign of how much they learn and apply science in their daily lives. (Türkmen, 2008). This study aims to examine the image of

scientists held by Turkish secondary school students and reveal how this image changed after the pandemic particularly with respect to scientists' emotions. The depictions made in previous research on this subject took the form of middle-aged or elderly male scientists wearing lab coats and glasses with a beard and wild hair (Barman, 1996; Bodzin & Gehringer, 2001; Chambers, 1983; Finson et al., 1995; Flick, 1990; Fort & Varney, 1989; Fung, 2002; Guler & Akman, 2006; Huber & Burton, 1995; Kahle, 1992; Rosenthal, 1993; Symington & Spurling, 1990; Thomas & Pedersen, 1998). The scientists drawn by the students in this study show a fall in the rates of the standards that constitute the stereotypical image. According to the students that made up the study group, scientists are younger than the stereotypical image. The scientists drawn by female students are women and these drawings are much more than just Marie Curie. The results show that the perceptions of female students are not limited to famous women scientists alone. They even imagined and depicted themselves as scientists. Traces of women scientists are also seen in the drawings made by the male students but less than the female students. Many researchers and educators think that the more stereotypical the image of the scientist in the minds of students is, the more positive their interest in and attitude towards science is. They also state that students will enter a profession directly related to science (Bodzin & Gehringer, 2001; Flick, 1990; MacCorquodale, 1984; Matkins, 1996; Rosenthal, 1993).

Studies have shown that when students describe scientists, they gain knowledge from the professional groups they come across in their environment as well as the traits of scientists (Guler & Akman, 2006). Studies of the relevant literature to identify the depicted scientists reveal that they are well-known researchers such as Albert Einstein, Thomas Edison and Isaac Newton (Takach & Tobi, 2021). On the other hand, there are more unnamed scientists drawn in this study than famous scientists such as Einstein, Newton and Edison. The students' drawings of famous scientists depicted Turkish scientists such as Nobel Prize winner Aziz Sancar and Uğur Şahin who made their mark on the COVID pandemic by discovering the BionTech vaccine. Uğur Şahin's drawings show that the pandemic has also changed the image of the scientist in the student's mind. The drawings of scientists wearing surgical masks are one of the clearest indicators of the effects of the pandemic. The pandemic affected and altered social life and signs of the pandemic are evident in these drawings. It can also be seen in the students' drawings of famous historical Turkish scientists such as Ali Kuşçu. Other research on the topic demonstrates that students particularly those from non-Western countries are more familiar with Western scientists like Einstein and Newton. Research data provide no pictures of scientists from their native cultures (Takach & Tobi, 2021). This study differs from the literature in this respect.

According to the students, scientists are knowledgeable, work hard and are always reading and doing research. Scientists and technology are inseparable. The perception of scientists in this research is similar to many other studies (Guler & Akman, 2006). In terms of the findings about the places in which scientists work, students preferred to depict scientists working outside those in formal, restricted environments like a laboratory. One of the most important factors affecting students who use the outdoors as a research environment is Newton pondering gravity under an apple tree. This is evident in the students' drawings. Analysis of the emotional content of the students' drawings revealed that scientists have more positive emotions such as joy and expectation. Optimism and love are observed most frequently in drawings where more than one emotion is present. There are proportionally fewer negative emotions than positive ones. Scientists depicted in this study are happy, doing useful work, optimistic and loving. This demonstrates a decline in the belief that scientific endeavors are dangerous or have the potential to create superhumans.

Recent developments have changed students' perceptions of scientists. The study by Mead and Metraux (1957) describe a scientist using a study group comprising high school students reported that the idea of the existing image of the scientist held by students did not disappear completely but that current ideas were changing and a standard new image was thus being formed. Most research on this subject shows that today's media and popular culture affect scientists' perceptions (Schibeci, 1986; Schibeci & Sorensen, 1983; Yager & Yager, 1985). Studies on

this subject state that classroom teaching activities affect the role of scientists (Talsma, 1997). Students' perceptions of scientists coincide with the goals of the current scientific curriculum explained by teachers who require their students to understand and explain science in the natural world with a sense of curiosity.

5. RECOMMENDATIONS

It is essential to explain the role of the scientist from the perspective of the students in order to create students who think like scientists. Conducting studies employing various educational levels, branches and cultures is an essential recommendation for future research. Today's media is one of the elements considered important in creating students' images of scientists. New research examining how scientists are depicted in the media now could reveal new information on this subject.

How students perceive scientists is affected by their teachers and the teaching activities they encounter. The literature will therefore benefit from research on how teachers perceive scientists. The DAST-C test and the eight primary emotions in the Plutchik emotion model were used as the basis for this study. Future research could conduct interviews to obtain more in-depth information.

This study is a survey study. Qualitative research methods can be used in future studies to provide more in-depth information about the perception of the scientist and experimental research can be used to explain the variables that are thought to alter this image.

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Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
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