

Are Students' Image of Scientists Affected by Parent and Teacher Factors? A Study on the Contextual Relationship between Students, Teachers, and Parents

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ABSTRACT For more than half a century, research has been carried out on the image of scientists. The media, textbooks, teachers, parents, and peer influence were assumed to be the basis of the stereotypical image. Empirical evidence regarding teachers' and parents' perceptions of scientists remains insufficient. This study investigated whether teachers' and parents' images of scientists affect students' images of scientists. Participants included students aged 8-11 (n = 122), parents (n = 104), and teachers (n = 82). Drawings collected via the Draw-a-Scientist Test (DAST) were analysed by the Draw-a-Scientist Test Checklist (DAST-C). The results showed that neither teachers nor parents had a significant effect on students' image of scientists. Therefore, the theoretical underpinnings of the origins of the stereotypical image of scientists were not supported by the study.

Keywords: Image of a scientist, Parent perception, Teacher perception, Primary school students

1. INTRODUCTION

Science and technology are prerequisite fields of knowledge for children raised as individuals conscious of science-based decision-making and science-oriented action through life-long science education. Through scientific learning, individuals can determine the value, strength, validity, and limitations of sources of knowledge they encounter. In addition, valid perceptions regarding the image of a scientist can be developed throughout this education (Ateş et al., 2021). In this context, the revised science curriculum in Turkey emphasizes training students to "think like scientists" and teachers who encourage their students to be people who "work by taking on the role of scientists" in classroom activities (Ministry of National Education, 2018). The most important reason for this emphasis on the scientist is their attitude towards science and the effect that the image of a scientist has on the students (Alkış Küçükaydın, 2018).

Mead and Mead (1957), the first to study the appearance of scientists, found that high school students portrayed scientists as male, wearing glasses, and working in a laboratory. This first study showed that students had an "image" of scientists (Beardslee & O'Dowd, 1961). One's image is a powerful tool for communicating or conveying a message or emotion (González et al., 2017, p. 537). For

this reason, the importance of the image of scientists in shaping students' perceptions and attitudes towards science was emphasised, and tools were developed to reveal that image (Chambers, 1983). Using the tools developed, drawings of scientists were analysed, and three images of scientists were identified. These are positive, stereotypical, and negative images of scientists (Subramaniam et al., 2013). To date, many studies have tried to reveal the negative and stereotypical images of scientists (Esen et al., 2022; Meyer et al., 2019; Schibeci, 2006). Accordingly, all characteristics that can characterise a scientist as typical are called stereotype images of scientists (Koren & Bar, 2009; Villar & Guppy, 2015).

In fact, studies on the image of scientists have reported that students' perceptions of science and images of scientists affect their attitudes toward science and future career choices (Buldu, 2006; Finson, 2002). For this reason, it is recommended to consider the image of a scientist and focus on its development from an early age (Bozzato et al., 2021). The principle here is that students form an image of scientists over time, and these images are more resistant to

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change than other school information (Alkiş Küçükaydın, 2018; Esen et al., 2022).

The relevant literature has touched upon the effects of school, peers, textbooks, media, and the behaviour of teachers and parents on students' image of scientists (Avraamidou, 2013; Christidou et al., 2012; Tan et al., 2015). In addition, extensive research has examined the effects of media and textbooks on the image of scientists conveyed to students. The impact of these factors on a scientist's image has been openly discussed. For example, Avraamidou (2013) states that movies, science fiction, and comics reflect stereotypical images of scientists. On the other hand, Tan et al. (2015) reported that popular media elements and magazines lead to unrealistic portrayals of children's images of scientists. Villar and Guppy (2015) examined the representations of scientists in 23 science books published by the Ministry of Education of British Columbia between 1950 and 2007. They relayed two important results: a) male scientists in key positions (e.g., receiving awards or holding authority) are represented at the forefront, and b) female scientists are shown in more limited roles (male-dominated career roles) than male scientists. Examining the image of scientists in Lebanese national science textbooks, Yacoubian et al. (2017) reported that scientists are portrayed in the laboratory. In addition, it has been claimed that students' image of scientists is also influenced by their teachers' and parents' behaviours. Consequently, attitude analyses were made using the students' data (Calabrese Barton et al., 2013; DeWitt & Archer, 2015; Türkmen, 2008). To this point, no scientific study appears to support the belief that parents' and teachers' perspectives on science affect the image children develop of science. Therefore, in this study, the image of a scientist as understood by teachers and parents is examined to determine whether it is connected to students' image.

1.1 Theoretical Background

Social Learning Theory

Social learning theory argues that individuals learn their behaviours not only through direct experience but also by observing others (Bandura, 1986). Within this framework, it is expected that children will be influenced by models in their environment—such as teachers, parents, media figures, and peers—as they shape their images of scientists. According to Bandura (1977), processes such as observational learning, modelling, and self-efficacy directly influence an individual's motivation and career orientation. In this context, the social models that shape students' perceptions of scientists can be explained by the basic principles of social cognitive theory.

Image of a Scientist

The first study of the image of scientists was conducted by Mead and Metraux (1957) at the high school level, while Beardslee and O'Dowd (1961) conducted a similar study a

few years later at the university level. Image studies have spread worldwide, including the Draw-A-Scientist-Test (DAST) by Chambers (1983). It began to better understand students' image of scientists. In most studies, scientists were depicted as males with messy hair and glasses, wearing a coat and working in a lab (Avraamidou, 2013; Buldu, 2006; Türkmen, 2008). The increase in the indicators obtained from DAST has been interpreted as the "stereotypical image of scientist" (Finson, 2002). A male is depicted in the stereotypical image of a scientist. Also, the scientist usually wears glasses, has a beard or moustache, and is bald or has messy hair. Additionally, the scientist has been depicted in an indoor environment, which includes research or technology symbols (Finson et al., 1995). However, in the studies covering the last 10-year period, changes in stereotypes have begun to be recorded. For example, in the study by Miller et al. (2018), female scientists were included. Children in the study of Emvalotis and Koutsianou (2018) portrayed younger scientists without beards and glasses, and Ferguson and Lezotte (2020) noted that mythical stereotypes had shrunk. These developments have been interpreted as advances in modern scientific understanding. However, the stereotypical image of a scientist has remained the same. Therefore, the factors that lead to the development of stereotypes are of curiosity. For this reason, images of scientists continue to be used with students across all age groups (DeWitt & Archer, 2015; Meyer et al., 2019).

Identifying the Image of a Scientist

Analyses of DAST, which is based on data collection via drawing, are conducted using the Draw-a-Scientist Test Checklist (DAST-C) (Finson et al., 1995), but alternative tools can be used (Farland-Smith, 2012). Despite recent criticisms (Reinisch et al., 2017) of using student drawings to depict scientists, DAST remains a popular method after 40 years of use. It is so commonly utilised because it does not require writing skills, allows data collection from all age groups, and is easy to apply (Bozzato et al., 2021; Milford & Tippett, 2013; Miller et al., 2018). Therefore, DAST was used in this study.

Limitations in the Image of Scientist Studies

The literature on the scientist image is nearly half a century old (Mead & Metraux, 1957) and has addressed the image structure of students of all age groups (Avraamidou, 2013). Nevertheless, some issues still need to be addressed in the literature. This may be related to the limitations mentioned in previous studies.

The first limitation in the image of scientific literature is that studies generally aim to reveal the current situation. Many studies have addressed students' images of scientists in line with the DAST-C guidelines (Finson et al., 1995), and a predominantly stereotyped image structure has been identified (Bozzato et al., 2021; Milford & Tippett, 2013; Tan et al., 2015). These studies evaluated students' images

of scientists within their own cultures and suggested investigating the sources of those images.

Other studies that addressed this suggestion as a source of motivation and investigated the image of scientists used students' opinions (Türkmen, 2008) and examined the depictions of scientists in textbooks and media sources (Tan et al., 2015; Yacoubian et al., 2017; Villar & Guppy, 2015). However, the main limitation of these studies is that they did not include teacher and parent factors.

The literature on teacher and parental factors affecting students' image of scientists is quite limited (DeWitt & Archer, 2015; Türkmen, 2008). Moreover, the limited number of studies that mentioned teachers and parents did not directly focus on their images. Instead, it was implied that these factors could influence students' perceptions of scientists (Christidou et al., 2012). In short, studies on students' images of scientists have primarily focused on the current state of those images and other factors that affect them.

Sample, Culture, and Stereotypes

DAST has been preferred in different age groups due to its convenience. Also, the majority of the studies focus on the primary school level (Alkiş Küçükaydın, 2018; Esen et al., 2022; Avraamidou, 2013; Bozzato et al., 2021; Emvalotis & Koutsianou, 2018; Tan et al., 2015), and there are also studies in which primary and secondary school students are evaluated together (DeWitt & Archer, 2015; Fung, 2002; Koren & Bar, 2009). In addition, the images of high school scientists (Christidou et al., 2012) and university students (Bovina & Dragul'skaia, 2008; Meyer et al., 2019; Milford & Tippett, 2013; Reinisch et al., 2017) were included as research subjects. These studies cover different cultures. Image research first began with Chambers' (1983) and Finson's (2002) studies in the US and Canada, and then spread to many European countries (Avraamidou, 2013; Bozzato et al., 2021; Christidou et al., 2012; DeWitt & Archer, 2015; Emvalotis & Koutsianou, 2018). The studies were not limited only to North American and European countries but also spread to Australia (Milford & Tippett, 2013), Singapore (Tan et al., 2015), China (Fung, 2002), Russia (Bovina & Dragul'skaia, 2008), Lebanon (Yacoubian et al., 2017), Israel (Koren & Bar, 2009), and even the African continent (Meyer et al., 2019).

In such studies examining images of scientists, it has been reported that the gender representation of scientists does not change in general. However, the structure of the stereotypes sometimes differs. In Western culture, students have been reported to describe a middle-aged man working alone in the laboratory and wearing a white lab coat or suit (black pants, white shirt, and black jacket) (Avraamidou, 2013; Bozzato et al., 2021). In studies in Australia and Singapore, there are fewer stereotypical drawings. In these locations, the drawings of male and female scientists are pretty similar (Milford & Tippett, 2013; Tan et al., 2015).

In studies conducted with Greek students, followed by follow-up studies, it was observed that boys tend to draw more stereotyped images than girls (Christidou et al., 2012; Emvalotis & Koutsianou, 2018). Similar stereotypes have been confirmed in studies conducted in Turkey (Türkmen, 2008), China (Fung, 2002), South Africa (Meyer et al., 2019), Israel (Koren & Bar, 2009), and Russia (Bovina & Dragul'skaia, 2008). In almost all of these studies, it has been emphasised that students' images of scientists may originate from school and parents. However, according to DeWitt and Archer (2015), attitudes toward school science and positive parental attitudes toward science do not necessarily indicate that children want to pursue a career in science. Therefore, a clearer perspective is needed on the factors shaping scientists' image.

1.2 Rationale of the Study

Aschbacher et al. (2010) reported that students who received family support displayed positive attitudes towards science. In the study by Cakmakci et al. (2011), it was reported that teachers' approach was practical in developing students' images of scientists. In these studies, data were collected through students' self-reports or drawings, and inferences were drawn from this material. However, teachers' and parents' images of scientists were not directly examined. Ateş et al. (2021) explored the image of scientists through the lens of students and teachers attending a science festival, but no direct connection was established between student and teacher images. The limited number of other studies dealing with teachers' images of scientists is also quite old (Rampal, 1992; Song, 1993). This data shows a severe research gap in the literature spanning about 50 years, which assumes that students' images of scientists are based primarily on teachers' and parents' attitudes. For many years, it has been reported that parental and teacher factors influence students' images of scientists. However, the data collected from teachers and parents has not supported this assertion.

We believe that there are two reasons why this assumption has not been addressed so far: a) there has been much focus on the changing image for many years but no discussion on the origins of the image, and b) the idea that the image of the scientist will be in line with that of adults due to the excess of adult supervision, especially in young children.

In short, the existing literature has examined students' images of scientists across many age groups (Bozzato et al., 2021; Christidou et al., 2012; Meyer et al., 2019). However, it has yet to address the origins of this image in the context of teachers and parents. One of the important goals of today's education system is to develop students' interest and abilities in science (Ministry of National Education, 2018). In this context, students' perceptions of the scientist's image can significantly influence their interest and motivation towards scientific careers (DeWitt & Archer, 2015; Toma et al., 2022). Teachers and their

parents are among the sources of students' interest and motivation (Ateş et al., 2021). Therefore, in this study, we examine the image of scientists held by teachers, parents, and students, and then examine the impact of the image held by teachers and parents on students.

Therefore, this study aims to reveal the image of the scientist as perceived by students, teachers, and parents in the Turkish sample. The research questions that will guide the study in line with this general purpose are as follows:

1. What is the image of scientists among primary school students, teachers, and parents?
2. What are the differences within the group in the images of scientists?
 - a. Is there a difference in the image of scientists according to the gender of the students?
 - b. Is there a difference in the image of scientists according to the variables of the teachers' gender and seniority?
 - c. Is there a difference in the image of scientists according to the gender and education level variables of the parents?
3. Are there differences between groups (students, teachers, and parents) when it comes to images of scientists?
4. Are teachers' and parents' images of scientists predictors of students' images of scientists?

2. METHOD

2.1 Participants

The participants in this study are teachers, students, and parents from a major city in the Central Anatolian Region of Turkey. A disproportionate stratified sampling technique was used to determine the sample. In this sampling technique, an equal number of participants is sampled from each stratum, regardless of the strata's sizes (Cohen, 2018). In this context, the participants were selected from three schools representing the low-, middle-, and high-income groups. An equal number of students

(average 40) and an equal number of parents (average 35) from each of the schools determined in this way were included in the sample. The study uses disproportionate stratified sampling because school classification is not based on formal procedures. Therefore, a precise figure for the number of students in schools in these strata cannot be reported.

There are specific reasons why three schools representing low, middle, and high-income groups were selected for the study. First of all, this study, which examines the image of scientists, aimed to increase the representativeness of the research and the generalizability of the results by taking samples from different socioeconomic groups. This is due to the desire to follow a more inclusive approach. In addition, sampling from low, middle, and high-income groups can contribute to more effective development of educational policies and practices. Factors such as transportation, educational facilities, number of teachers, access to technology, and class size were considered in selecting these schools, reflecting different income groups.

The school in the study, located in a low-socioeconomic neighbourhood, is in a neighbourhood with notoriously difficult transportation compared to other areas. There are many refugee students at the school, and their parents' education levels are generally low (primary school level or illiterate). All of the parents who participated in the study were Turkish. The majority of parents in this school are farmers or labourers. The school is public and at a middle socioeconomic level, and its parents are generally middle-income civil servants. In addition, the children's mothers are usually housewives. Therefore, those in this group usually have income dependent on a single person. The school is a private school with a high socioeconomic level, and its parents are mostly white-collar. In this context, both parents of the children work in well-paying professions. In addition, this school serves as a public school's sibling school.

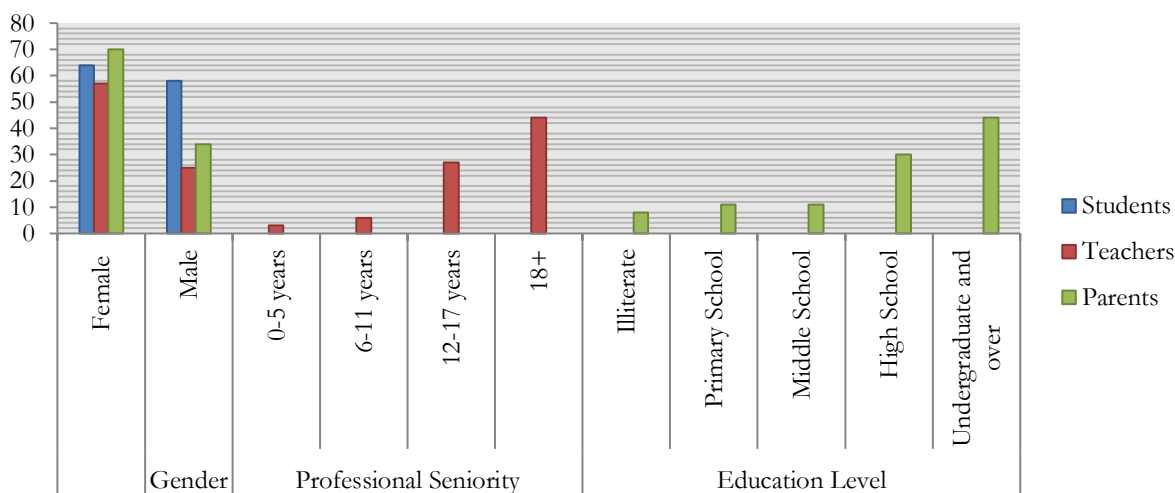


Figure 1 Information about the participants

A total of 122 students ($M_{age}=8.68$, $SD=.97$) from the 8-11 age group studying at these schools and 104 adults ($range=24-70$, $M_{age}=39.20$, $SD=7.45$) who are the parents of these students participated in the study. In addition, 82 primary school teachers ($range=25-55$, $M_{age}=41.40$, $SD=4.91$) were included in the study. Information about the participants of the study is presented in Fig.1. Among the teachers participating in the study, three had 0-5 years of experience (2.5%), six had 6-11 years of experience (6.6%), 27 had 12-17 years of experience (22.1%), and 44 had 18 or more years of experience (36.1%). Twenty-seven teachers have master's degrees, and the others have bachelor's degrees. As far as the parent education level is concerned, eight were illiterate (6.6%), 11 had a primary school level education (9.0%), 11 were considered to be at secondary school, 30 were considered high school level (24.6%), and the remaining 44 were at a level of education considered either undergraduate or higher (36.1%). Information about the sample is presented in Fig.1.

2.2 Instruments and Procedures

A personal information form and DAST (Chambers, 1983) were used to collect participant data. The form was tailored separately for students, teachers, and parents. In the student form, the students were asked about their gender and age. Teachers were asked to give their age, gender, and years of professional experience, while parents were asked to provide their age, gender, and education level. In the DAST application, a blank sheet of paper was provided to participants, and the instruction to "draw a picture of a scientist" was given.

At the data collection stage, permission from the ethics committee was obtained first, and then the application permission from the institutions was granted. Teachers were contacted in line with permissions. After the forms were emailed to the primary school teachers, 80 of them provided feedback. Parent permissions were obtained in written form through the teachers. After obtaining parents' permission, the researchers administered the student form during free activity hours, with the help of 12 primary school teachers, and the drawings were made. The students were given a blank A4 paper and colored pencils, and the DAST instruction was applied. The parent form was applied during parent meetings. The primary school teachers introduced the research at the end of the parent meeting and invited parents to participate. Those who wanted to participate in the research stayed in the room after the meeting concluded. The researchers applied the DAST instruction by distributing blank A4 papers and colored pencils to the parents.

2.3 Validity and Reliability

Cohen's kappa (κ) was used to assess the reliability of DAST-C scores. In this context, inter-coder values were calculated in the study. Drawings for students, teachers, and parents were evaluated separately (Students- traditional stereotypical images of scientists [$\kappa =.91$], alternative

stereotypical images of scientists [$\kappa =.90$], teachers-traditional stereotypical images of scientists [$\kappa =.89$], alternative stereotypical images of scientists [$\kappa =.91$], parents- traditional stereotypical images of scientists [$\kappa =.90$], alternative stereotypical images of scientists [$\kappa =.90$]). Based on the high fit values obtained, the reliability of the drawing analyses was high.

2.4 Data Analysis

A checklist for the Draw-A-Scientist-Test (DAST-C) developed by Finson et al. (1995) was used to analyse the drawings obtained from DAST. However, DAST-C was adopted in this study, although the ethnic origin information in the original DAST-C was not found in the drawings. In this context, the analyses were made on 14 indicators outlined by Emvalotis and Koutsianou (2018). Seven indicators represent traditional, stereotypical images of scientists, and the other seven represent alternative stereotypical images. All indicators in DAST-C are scored as 1 or 0 based on whether the indicator is present or absent. The scores obtained were analyzed in three categories based on Finson's (2002) suggestion: a) traditional stereotypical images of scientists (0-7 points from the first seven indicators = Upper Scale), b) alternative stereotypical images of scientists (0-7 points from the last seven indicators = Lower Scale) and, c) DAST-C total point (A total score of 0-14 from 14 indicators reflecting traditional and alternative stereotypical images of scientists = Total Score).

The DAST-C scores were first analyzed to determine whether the data met the normality assumptions. In this context, skewness and kurtosis values for each dimension were examined (upper scale students= $-.141$ and $-.498$; lower scale students= $-.239$ and $.223$, total score students= $-.039$ and $-.107$; upper scale parents= $-.410$ and $-.897$; lower scale parents= $-.389$ and $-.475$; total score parents= $-.113$ and $-.213$; upper scale teachers= -1.06 and $.404$; lower scale teachers= $-.633$ and $-.069$; total score teachers= $.140$ and $-.982$) and it was determined that the values reached were between ± 1.5 . Accordingly, the data were normally distributed (Tabachnick & Fidell, 2007). Then, an independent sample t-test and a one-way ANOVA were used for group comparisons.

However, the groups were rearranged because the number of people in the 0-5 years and 6-11 years cells in the years of teachers' seniority variable was below 15 (Green & Salkind, 2005). Accordingly, 15 years of experience were used as a reference in the examinations, based on teachers' seniority. So, 29 people had 15 years of seniority or less, and 53 had more than 15 years. A similar grouping was also used to measure the parents' education level. The groups were then combined, and arrangements were made to include 1) primary education and lower education ($n=30$), 2) high school ($n=30$), and 3) undergraduate and higher education ($n=44$). Regrouping this way was to make stronger statistical analyses and to

reveal the differences between groups. Both simple linear and multiple linear regression analyses were used to determine whether teacher and parent images predicted students' images of scientists.

3. RESULT

The findings obtained within the scope of the study are presented by addressing the research questions.

3.1 Primary school students, teachers, and parents' image of a scientist

The drawings made by primary school students, their parents, and teachers were examined using DAST-C indicators, and the findings are presented in Table 1. It has already been established that a large proportion of students (n=100, 81.96%) included research symbols in their drawings and described the scientist's gender as male

Table 1. Frequency and percentage distribution of participants' scores from DAST-C indicators

Indicators	Students (n=122)	Parents (n=104)	Teachers (n=82)
Traditional Stereotypical Images of Scientist = Upper Scale			
1. Lab coat	59 (48.36%)	54 (51.92%)	58 (70.73%)
2. Eyeglasses	49 (40.16%)	56 (53.84)	63 (76.82%)
3. Facial hair: Beards, moustache, or abnormally long side bums	73 (59.83%)	72 (69.23%)	64 (78.04%)
4. Symbols of research: Scientific instruments and lab equipment of any kind	100 (81.96%)	79 (75.96%)	71 (86.58%)
5. Symbols of knowledge: Principally books, filing cabinets, clipboards, pens in pockets, briefcases, etc.	69 (56.55%)	70 (67.30%)	70 (85.36%)
6. Symbols of technology- the product of science: phones, rockets, robots, computers, etc.	51 (41.80%)	60 (57.69%)	62 (75.60%)
7. Relevant captions: Formulae, taxonomic classification or the "eureka!" syndrome	27 (22.13%)	37 (35.57%)	30 (36.58%)
Alternative Stereotypical Images of Scientist = Lower Scale			
1. Gender (male)	101 (82.78%)	86 (82.69%)	73 (89.02%)
2. Indications of danger: Explosions, warnings, etc.	56 (45.90%)	9 (8.65%)	26 (31.70%)
3. Presence of light bulbs	41 (33.60%)	29 (27.88%)	26 (31.70%)
4. Mythical stereotypes: Frankenstein creatures, Jekyll/Hyde figures, or "mad/crazy"	28 (22.95%)	3 (2.88%)	2 (2.43%)
5. Indicators of secrecy: Signs or warnings of "private", "keep out", "do not enter", "go away", "top secret", etc.	7 (5.73%)	0	3 (3.65%)
6. Scientist doing work indoors (usually but not necessarily in a laboratory)	96 (78.68%)	60 (57.69%)	60 (73.17%)
7. Middle aged or elderly scientist	99 (81.14%)	95 (91.34%)	70 (85.36%)

Table 2 DAST-C score comparisons by gender of participants

Variables	Scale	Gender	n	M	SD	df	t	p	d
Students	Upper Scale	Girls	64	3.35	1.73	120	-1.01	.31	
Students	Upper Scale	Boys	58	3.67	1.66	120	-1.01	.31	
Students	Lower Scale	Girls	64	3.18	1.47	120	-2.55	.01*	.46
Students	Lower Scale	Boys	58	3.86	1.43	120	-2.55	.01*	.46
Students	Total Score	Girls	64	6.54	2.80	120	-2.00	.04*	.36
Students	Total Score	Boys	58	7.53	2.63	120	-2.00	.04*	.36
Parents	Upper Scale	Female	70	4.04	2.14	102	-.49	.62	
Parents	Upper Scale	Male	34	4.26	2.12	102	-.49	.62	
Parents	Lower Scale	Female	70	2.68	1.14	102	-.35	.72	
Parents	Lower Scale	Male	34	2.76	.92	102	-.35	.72	
Parents	Total Score	Female	73	6.72	3.02	102	-.49	.62	
Parents	Total Score	Male	34	7.02	2.75	102	-.49	.62	
Teachers	Upper Scale	Female	57	4.84	1.96	80	-1.75	.08	
Teachers	Upper Scale	Male	25	5.68	2.05	80	-1.75	.08	
Teachers	Lower Scale	Female	57	3.12	1.21	80	-.54	.59	
Teachers	Lower Scale	Male	25	3.28	1.20	80	-.54	.59	
Teachers	Total Score	Female	57	7.96	2.99	80	-1.40	.16	
Teachers	Total Score	Male	25	8.96	2.83	80	-1.40	.16	

($n=101$, 82.78%). Three examples of student drawings are presented in Appendix B. In the first example, the symbols of research and technology are included in the drawing; in the second, the scientist is depicted as a man; and in the third, images show how a scientist works.

It was also observed that most parents drew a male scientist ($n=95$, 91.34%) and portrayed the scientist as old ($n=86$, 82.69%). In the first and second images in Appendix B, which present examples of parents' drawings, we see complex symbols and a drawing of a scientist with messy hair. The third image depicts the scientist in a more dangerous light. Most of the teachers ($n=70$, 85.36%) portrayed the scientist as old, and they drew a male scientist ($n=73$, 89.02%). In the first appendix image, Einstein is depicted as a scientist. In the second and third images, there are complex symbols and the depiction of a male scientist. This situation shows that there is a common stereotypical understanding of the scientist's gender across all

participating groups. Also, for both parents and teachers, scientists are older people.

3.2 Within-group differences in the image of a scientist

The findings from the DAST-C score analyses of the participant groups are presented in Table 2 by gender. Accordingly, students' images of scientists show significant differences in the DAST-C's lower-scale and total-score dimensions. So, male students had more alternative stereotypical images of scientists ($t(120) = -5.55$, $p < .05$, $d = .46$). This situation also affected the total score on the DAST-C ($M = 7.53$, $SD = 2.63$). The image of scientists according to adults' gender has not shown a significant difference.

The analysis of the teachers' DAST-C scores by seniority is presented in Table 3. The results of the analysis showed that teachers with 15 years or less experience possess a stereotypical image of a high scientist ($t(80)=1.93$, $p<.05$, $d=.45$). In the sub-dimensions of DAST-C, the

Table 3 DAST-C score comparisons of teachers by year of seniority variable

Variable	Scale	Professional Seniority	n	M	SD	df	t	p	d
Teachers	Upper Scale	15 years or less	29	5.65	1.73	80	1.81	.07	
Teachers	Upper Scale	15+ years	53	4.84	2.01	80	1.81	.07	
Teachers	Lower Scale	15 years or less	29	3.48	1.21	80	1.69	.09	
Teachers	Lower Scale	15+ years	53	3.01	1.16	80	1.69	.09	
Teachers	Total Score	15 years or less	29	9.13	2.65	80	1.93	.04*	.45
Teachers	Total Score	15+ years	53	7.86	2.94	80	1.93	.04*	.45

Table 4 DAST-C score comparisons according to parents' educational status variable

Scale	Scale	n	M	SD	Sum of Squares	df	F	p
Upper Scale	Primary education and lower education	30	3.70	2.30	Between Groups=7.39 Within groups= 461.21	Between Groups=2 Within groups= 101	.81	.81
Upper Scale	High school	30	4.33	2.23	Between Groups=7.39 Within groups= 461.21	Between Groups=2 Within groups= 101	.81	.81
Upper Scale	Undergraduate and higher education	44	4.25	1.94	Between Groups=7.39 Within groups= 461.21	Between Groups=2 Within groups= 101	.81	.81
Lower Scale	Primary education and lower education	30	2.93	1.04	Between Groups=2.46 Within groups= 116.87	Between Groups=2 Within groups= 101	1.06	.34
Lower Scale	High school	30	2.53	1.16	Between Groups=2.46 Within groups= 116.87	Between Groups=2 Within groups= 101	1.06	.34
Lower Scale	Undergraduate and higher education	44	2.68	1.02	Between Groups=2.46 Within groups= 116.87	Between Groups=2 Within groups= 101	1.06	.34
Total Score	Primary education and lower education	30	6.63	3.04	Between Groups=1.65 Within groups= 881.22	Between Groups=2 Within groups= 101	.09	.91
Total Score	High school	30	6.87	3.13	Between Groups=1.65 Within groups= 881.22	Between Groups=2 Within groups= 101	.09	.91
Total Score	Undergraduate and higher education	44	6.93	2.75	Between Groups=1.65 Within groups= 881.22	Between Groups=2 Within groups= 101	.09	.91

group with less professional seniority scored higher than the group with higher professional seniority ($M=9.13$, $SD=2.65$).

The analysis of the parents' DAST-C scores is presented in Table 4. According to this information, the images of scientists do not differ by parents' educational level ($p>.05$).

3.3 Between groups, differences in images of scientists

The DAST-C score comparisons for students, teachers, and parents are presented in Table 5. It is evident that the scores of the participants from the DAST-C scale have a significant difference between the groups ($F(2,305)=6.62$, $p<.05$, $n2=.04$). According to the results of Tukey's HSD post hoc analysis ($p=.07$, 95% C.I. = .28/2.21; $p=.02$, 95% C.I. = .44/2.44) conducted to determine the source of the difference, it was determined that the DAST-C scores of the students ($M=7.01$, $SD=2.75$) and parents ($M=6.82$, $SD=2.92$) were lower than the DAST-C scores of the teachers ($M=8.26$, $SD=2.96$).

3.4 Predictors of students' image of a scientist

This study was conducted to determine whether students' image of a scientist could be predicted from teachers' and parents' perceptions. The findings, derived from a simple regression analysis, indicated that neither the parents' nor the teachers' image of a scientist significantly predicted the students' image ($F(1,102)=.231$, $p>.05$ with an R^2 of .002). Similarly, teachers' image of scientists does not significantly predict students' image of scientists. ($F(1,80)=2.377$, $p>.05$ with an R^2 of .029).

Then, whether teachers' and parents' images of scientists together predict students' image (Table 6) was tested. Multiple linear regression was used to test whether the image of the scientist across the two groups together predicted students' image of the scientist. A significant regression equation was not found ($F(2,79)=1.297$, $p>.05$; $R^2=.032$).

4. DISCUSSION

In the image of scientific research, which started with the studies of Mead and Metraux (1957) and continued until today, teacher and parent factors were pointed out as the source of stereotypical images of students (Archer et al., 2015; DeWitt & Archer, 2015; Calabrese Barton et al., 2013). However, the image of scientists that teachers and parents possess has not been examined beyond a surface-level inquiry. In previous studies, the sources of the scientists' images that students had were based on data collected from students via self-report (DeWitt et al., 2011; Türkmen, 2008). However, no study has been conducted with adults who are the real addressees of this image. Therefore, this study was conducted for such a purpose. In the study, students, teachers, and parents were asked to make drawings in line with the DAST protocols, and the drawings were then analysed using 14 indicators outlined in DAST-C (Emvalotis & Koutsianou, 2018).

The analysis showed that students, teachers, and parents hold stereotyped views of scientists' gender. This finding confirms previous findings in the image of scientific literature (Buldu, 2006). In addition, most students included research symbols in their drawings and depicted scientists indoors (Emvalotis & Koutsianou, 2018; Meyer et al., 2019). When participants' DAST-C scores were examined by gender, male students showed more alternative stereotypical images than female students. Although this finding is common in studies conducted in Western societies (Bozzato et al., 2021; Emvalotis & Koutsianou, 2018), it is revealed that students draw danger indicators and mythical stereotypes in Turkish society. All findings obtained from the students were repeated from previous literature (Christidou et al., 2012; Ferguson & Lezotte, 2020).

In the study, it was seen that teachers with 15 years or less of teaching experience had more stereotypical image

Table 5 DAST-C score comparisons of students, teachers, and parents

Scale	Groups	n	M	SD	Sum of Squares	df	F	p	n2	Significant difference
Total Scale Students (A)		122	7.01	2.75	Between Groups=109.90 Within groups= 2516.94	Between Groups=2 Within groups= 305	6.65	.00*	.04	A-C, B-C
Total Scale Parents (B)		104	6.82	2.92	Between Groups=109.90 Within groups= 2516.94	Between Groups=2 Within groups= 305	6.65	.00*	.04	A-C, B-C
Total Scale Teachers(C)		82	8.26	2.96	Between Groups=109.90 Within groups= 2516.94	Between Groups=2 Within groups= 305	6.65	.00*	.04	A-C, B-C

* $p<.05$

Table 6 Multiple regression analysis results on predicting students' image of a scientist

Variable	B	SDB	β	t	p	r
Constant	8.75	1.37	-	6.37	.00	
Parent	-.05	.11	-.05	-.48	.62	.00
Teacher	-.18	.11	-.18	-1.61	.11	-.17

structures. This may indicate that teachers come from different cultural tendencies and cultural capitals. Therefore, a higher awareness of science can explain the lack of stereotypical images among older teachers. Alternatively, it is possible to say that the younger generation has a more stereotypical image structure. Older teachers may have been aware of the requirements of raising a "student who thinks like a scientist". This situation also shows that the contents of the updated teacher training programs in Turkey should be opened to discussion.

In addition, stereotypes held by parents were also reported in the study. Contrary to the literature, it was found that teachers' and parents' images of scientists did not affect students' images of scientists. Moreover, it was determined that teachers had more stereotypical indicators than either students or parents. These stereotypes included lab coats, eyeglasses, facial hair, symbols of research, symbols of knowledge, symbols of technology, relevant captions, and gender. This can be associated with teachers' understanding of the nature of science (Lederman & Abd-El-Khalick, 1998).

According to Sharma and Honan (2020), the image of a scientist conveys beliefs about the nature of science. Therefore, individuals' belief structures may affect their images. Although it is difficult to change an individual's beliefs (Posnanski, 2002), belief differentiation can be achieved through educational programs (Stuart & Thurlow, 2000). According to Finson (2002), the image of scientists that teachers and pre-service teachers hold is influenced by the science education programs they receive. In the study by Milford and Tippet (2013), it was reported that different training programs offered to pre-service teachers positively change their perceptions of themselves. This indicates that the content of science education presented to pre-service teachers and the content of teachers' in-service training should be discussed. A sound understanding of science will shape knowledge of the nature of science and, therefore, the image of a scientist (Sharma & Honan, 2020).

According to DAST analysis, the scientist was mainly depicted as old in parent and teacher drawings. The association of experience and knowledge with age in Turkish culture may have influenced the drawings of adults. Miller et al. (2018) claimed that individuals are exposed to more cultural stereotypes as they age. This may be why the drawings reflect Turkish culture in both teacher and parent drawings. Although it is considered a stereotypical view that scientists' perceptions do not change with their parents' educational level, it may be a social representation. Because adults have more social stereotypes than children (Symington & Spurling, 1990), the picture they draw may not reflect their ideas.

The instructions to "draw a scientist" in the DAST protocol do not have an exact equivalent in Turkish, which is a masculine language. Drawings that emerge from the connotations of the concept of "scientist" may not reflect

real beliefs. Therefore, this study may also address methodological problems related to the DAST and its protocol, which have been criticised for a long time (Chang et al., 2020; Losch et al., 2008; Reinish et al., 2017).

The literature also offers some criticisms about the use and interpretation of DAST. Reinisch et al. (2017) emphasised that each drawn symbol may have multiple meanings; therefore, additional protocols are needed to interpret DAST. Similarly, Rapp and Kurby (2008) pointed out that a symbol can be a significant representation and challenging to interpret. Losh et al. (2008) emphasised that DAST is primarily related to drawing ability.

In addition, Finson and Pederson (2011) noted that individuals may not draw exactly what they have in mind, but instead draw a figure of a scientist that others can easily understand. Miele (2014) also reported that the instructions in the DAST drawing were directive. Accordingly, saying "draw a scientist" prevents participants from drawing scientists working collaboratively. All of this suggests concerns about the DAST's validity and reliability. All of these concerns may also apply to the current study. Although student, teacher, and parent drawings were analysed for validity and reliability, unanticipated methodological problems with the DAST may have affected the study's findings.

4.1 Adults do not influence students' image of scientists, So What?

Contrary to our initial assumptions, the study found that students' perceptions of their teachers and parents did not influence their images. This unexpected finding could be attributed to several factors. First, the validity and reliability issues with DAST (or DAST-C) may have affected the findings. According to Schibeci (2006), even if individuals do not have stereotypical images, stereotypical drawings can be used to increase clarity. Sometimes, the polysemy structure of the drawings obtained with DAST cannot be thoroughly analysed. For example, the "glasses" symbol, considered a stereotypical image according to Reinish et al. (2017), can sometimes symbolise a busy, forgetful, or important person. Therefore, the indicators in DAST-C do not always mean a stereotypical image. This suggests that additional instruments should be used to explain or support the DAST findings.

One of the remarkable findings of the study is that the students included more mythical stereotypes and indicators of secrecy drawings than in previous studies (Türkmen, 2008). However, these indicators were either never used in adult drawings or were used at levels below 4%. Therefore, students' image structure may be influenced by peers, media, textbooks, or cartoons outside the world of adults. These indicators have been described as stereotypes of children living in Western societies, although that tendency is changing (Ferguson & Lezotte, 2020). With the development of media and communication technologies, children's access to social media channels has increased

their exposure to the same stereotypes as other children around the world. This can be interpreted as an effect of globalisation on children. In addition, popular media, including print and electronic content, have been reported as effective factors in studies examining the origin of students' images of scientists (Steinke et al., 2007; Tan et al., 2015).

Children's image structure results from cultural, economic, and scientific capital, as well as family and school contexts (Toma et al., 2022). Positive results have been obtained in studies investigating the effects of scientific activities on students' perceptions of scientists. For example, in the study by Ateş et al. (2021), students participating in the science festival began drawing mostly happy female scientists and painting scientists in various places. Karaçam et al. (2021) applied a visiting-scientist approach, supported by conceptual change activities, to high school students for 6 days, and reported that, at the end of the training, students experienced changes in their images of the scientist's gender and the place where s/he worked.

Finally, Hite and White (2022) reported that participation in an after-school environmental club for one year contributed to developing thought in the context of the scientist's gender, job, and values. This shows that science capital is a factor that explains image development. However, there is limited literature on the relationship between science capital and the image of the scientist (Archer et al., 2015; Finson, 2002; Toma et al., 2022). Based on this, we assume that scientific capital can impact the image.

Although the study revealed that teachers' and parents' perceptions did not significantly predict students' images of scientists, this finding can be interpreted through the lens of Bandura's Social Cognitive Theory. According to Bandura (1986), individuals learn not only through direct experience but also by observing others—particularly role models such as parents and teachers. The lack of predictive power found in this study suggests that observational learning may be more nuanced in the context of science identity formation. Students may rely more on peer interactions and media representations than adult models when constructing their image of scientists, indicating a shift in the sources of modelling (Bandura, 1997). This finding invites a reconsideration of the applicability of social cognitive mechanisms in early science education contexts.

4.2 Limitations and Recommendations

In the study, an assumption frequently raised about the image of the scientist, well established in the literature, has been tested. However, the following limitations should be considered when generalising the findings.

First, the study was conducted with a sample of primary school students, teachers, and parents in Turkey. It is well known that culture is highly effective in shaping the image

of scientific studies (Bozzato et al., 2021; Meyer et al., 2019; Yacoubian et al., 2017). For this reason, this assumption ought to be retested in different cultural contexts.

DAST' was preferred because the participants in the study were young, and some parents were illiterate. However, there are long-standing debates regarding the validity and reliability of DAST' (Reinisch et al., 2017). The inability of people to fully express their perceptions through drawings is a significant limitation. For this reason, it is recommended to use additional supportive tools to determine the image of young children and illiterate groups.

Although previous research has collected data from regions with varying socioeconomic levels, it should be acknowledged that the participating groups' cultural and scientific capital differ. Although public and private school status have been mentioned, other factors may also explain the variability in schools. Therefore, limiting the study's findings only to the information collected from this sample may be healthy. In future studies, variables such as scientific capital, trust in science and scientists, and teachers' understanding of science can be evaluated together. In addition, a new categorisation was applied when analysing the data based on the number of samples. This allowed for a more robust analysis of the study.

However, it may be better to increase the number of samples per category in future studies. This may provide more robust analyses and the opportunity to examine and evaluate the sample in more detail. In addition, teacher-parent interaction was not tested in the analyses. Future studies could consider this and include terms such as "teacher-parent support, teacher-parent communication or attitude" as interaction terms.

Finally, in this study, the effect of teachers' and parents' images of scientists on students' images of scientists was examined. The analysis found that adults' images of scientists did not predict students' images of scientists. However, the literature also points to other factors that may impact the development of this image. Therefore, we suggest that other variables be included in future studies. With the modelling studies, an idea can be obtained about the effects of the factors on the image separately and together.

5. CONCLUSION

In this study, a literature assumption was tested. For a long time, it has been assumed that students' image of scientists is influenced by their parents' and teachers' images, and these variables have been identified as the source of stereotypical images. However, the study found that teachers hold more stereotypical images than students and parents. Teachers with lower professional seniority, that is, younger, have more stereotypical images than teachers with more experience. Moreover, it was found that students' images of the scientists were not predicted by parents' and teachers' images of scientists. The

interpretation of these findings was that factors outside the parent-teacher relationship played a role in students' perceptions. In addition, questions about whether DAST is a good tool in the image of scientific studies were also brought to the forefront of the discussion.

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