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Research Article

Scientist-Image Stereotypes: The Relationships among their Indicators

Sedat Karaçam[1]
Düzce University

Abstract

The aim of this study is to examine primary school students' scientist-image stereotypes by considering the relationships among indicators. A total of 877 students attending Grades 6 and 7in Düzce, Turkey participated in this study. The Draw-A-Scientist Test (DAST) was implemented during the 2013-2014 academic year to determine students' images about scientists. The data obtained through DAST was coded using DAST-C. The relationships among indicators of scientist-image stereotypes were analyzed using the chi-squared test. The results of analysis showed some relationships among the indicators of scientist-image stereotypes. Also, the indicator of untidy hair was found to be a core indicator among students who participated in this study. According to the findings, students had different tendencies regarding the image of a scientist. Thus, the analysis that was used in this study could also be implemented to determine the tendencies of students from different cultures and grades. On the other hand, this analysis approach, which was able to provide some core indicators, could guide future studies that aim to revise students' scientist-image stereotypes.

Keywords

Visual image • Science • Scientist image • Image stereotype • Middle-school students

1 **Correspondence to:** Sedat Karaçam (PhD), Department of Educational Sciences, Düzce University, Düzce, 81100 Turkey. Email: sedatkaracam@duzce.edu.tr

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These days, the importance of science and scientific knowledge is gradually increasing. In this sense, the importance of the scientist who directs science and scientific activities also increases. Bringing different perspectives to science is thought to enable countries to have a voice in scientific principles. Thus, stakeholders, educators, and researchers strive for students to have positive images of scientists. The studies in this field can be examined in two dimensions. The aim of studies from the first dimension is to examine students' scientist-images and the effects that individual differences have on this image in several countries at various educational levels. The aim of studies from the second dimension is to revise the images that are defined negatively, that stereotype. A large proportion of studies relevant to this field have been concerned with the first dimension. These studies have respectively been presented in a theoretical framework.

Theoretical Framework

The first dimension: student's scientist-images based on certain variables. The first study regarding the identification of scientist-images was conducted by Mead and Metraux (1957). Results from this study showed that students generally defined scientists through stereotypes, as shown in the following statement from the researchers:

> The scientist is a man who wears a white coat and works in a laboratory. He is elderly, or middle aged, and wears glasses . . . he may have a beard . . . He is surrounded by equipment: test tubes, Bunsen burners, flasks, and bottles, a jungle gym of blown glass tubes, and weird machines with dials. . . He writes neatly in black notebooks . . . One day he may sit up and shout: "Eureka! I've found it!". . . Through his work, people will have new and better products . . . He has to keep dangerous secrets . . . His work may be dangerous . . . He is always reading a book (p. 386).

From 1957 to 1983, semantic differential scales, Likert-type scales, and essays were used in various studies, from Mead and Metraux (1957) to Chambers (1983). For instance, Beardslee and O'Dowd (1961) used a scale composed of open-ended questions with a semantic differential scale; Krajkovich and Smith (1982) utilized a Likert-type scale. Results from studies undertaken in the 1960s and 70s showed that students' scientist-image stereotypes were resistant to change and common for individuals from various cultures worldwide.

In 1983, Chambers's study was an important attempt to determine students' scientist-images. In his study, Chambers developed the Draw-A-Scientist Test (DAST) and a code list relevant to it. Chambers (1983) described the scientist-images of 4,807 primary-school students (preschool through 5th grade) from their drawings. Research results showed that students generally perceived scientists as: males with beards or mustaches who wear lab coats and eye glasses, use technological devices, work alone in environments equipped with chemical substances and tools, and are adorned with knowledge symbols such as books and filing cabinets. Chambers coded student drawings on these categories and provided analyses using the frequency of category-use in drawings. The researcher pointed out that scientist-image stereotypes were generally first seen in second or third grade, and this image became the norm over time. Based on Chambers's approach, various studies have been conducted to determine students' scientist-images and the effects of individual differences on this image in several countries at various educational levels. Studies that have aimed to determine the effect of individual differences on this image in several countries at various educational levels have emphasized gender, culture, socio-economic level, age (grade), and academic discipline. In the results of these studies (Finson, 2002; Finson, Beavor, & Cramond, 1995; Medina-Jerez, Middleton, & Orihuela-Rabaza, 2011; Newton & Newton, 1998; She, 1995) students were generally found to have the scientist-image stereotypes presented by Chambers (1983). In regard to individual differences, students' gender, age, academic department, socio-economic level, and culture were found to affect their scientist-images. Studies that emphasized the effect of gender (Chambers, 1983; Matthews, 1996; Medina-Jerez et al. 2011) showed that boys' scientist-images were more stereotypical than girls. Chambers stated that while girls tended to draw scientists as women, boys tended to draw them as men. Like Chambers (1983), other researchers (Barman, 1999; Bowtell, 1996; Buldu, 2006; Fung, 2002; She, 1998) achieved the same results. Another factor affecting students' scientist-images is the students' academic discipline (Bilen, Ozel, & Bal, 2012; Milford & Tippett, 2013). According to Bilen et al. (2012), the scientist images of students enrolled in primary-school mathematics education departments are more stereotypical than their counterparts who have enrolled in history science departments. In relation to the socio-economic levels of students, scientist-images of students with high socio-economic standing were stated to be more stereotypical than those of students with lower socio-economic standing according to Chambers (1983) and Ruiz-Mallen and Escallas (2012). According to Chambers, this result is interesting because all students have interacted with this scientist-image stereotype by watching cartoons from an early age.

While consensus has been reached about the effects of gender and age on students' scientist-images, there are conflicting views about the effect of culture. Some studies (Finson, 2002; Manabu, 2002; Rodari, 2007) have shown no statistically significant difference among the scientist-images of students who participated from different countries. These researchers stated that because scientists' profiles have been presented in media and textbooks as stereotypes in many countries, there is no difference among students from different countries. However, Koren and Bar's (2009) and Rubin, Bar, and Cohen's (2003) studies, which were conducted in Israel, showed that while Arabic students tended to draw scientists as religious scholars, Jewish students tended to draw scientists similar to their Western counterparts. On the basis of this finding, researchers have stated that the culture of students affects their scientist-images.

Similarly, many studies have been conducted to determine the scientist-images of students in various grades in Turkey since 2000. Among these studies, Özel and Doğan (2013), Özgelen (2012), Karaçam (2015), Türkmen (2008), and Yontar-Toğrol (2013) determined the images of primary school students; Akçay (2011) investigated the images of primary and secondary school students; and Bilen et al. (2012), Demirbaş (2009) and Uçar (2012), researched the images of teacher candidates. As a result of these studies, researchers stated that students predominantly have scientist-image stereotypes and that students' gender, age, academic educational department, and socio-economic level are the factors that affect their scientist-image.

The second dimension: studies relevant to revising the stereotypical scientist-image. Students with stereotypical scientist-images perceive scientists as very boring individuals who work non-stop; therefore students develop negative attitudes towards science (Flick, 1990). She (1998) pointed out the negative relationships of scientist-image stereotypes with careers in science, reporting that there was a lower tendency for individuals with scientist-image stereotypes to choose a career in science. Moreover, She (1998) stated that a realistic revision of students' scientist-image stereotypes would positively affect their attitudes towards science and their future career options in science. From this perspective, many studies have been conducted in the literature on altering students' scientist-image stereotypes. These studies utilized approaches such as visiting scientists (Scherz & Oren, 2006; Smith & Erb, 1986) and science camps (Farland-Smith, 2012), inviting scientists to class (Bodzin & Gehringer, 2001; Mason, Kahle, & Gardner, 1991), inviting scientists to class and visiting them in their environment (Flick, 1990; Hopwood, 2012), hands-on research activities (Avraamidou, 2013), and presenting scientists' biographies (Sharkawy, 2009). As a result of these studies, the approaches that were implemented in these studies, such as science camps, hands-on research activities, and so on, were stated to enable students to revise or enhance their scientist-images.

Similar studies have been conducted in Turkey and pointed to the same results as in the literature. Among these studies, Leblebicioğlu, Metin, Yardımcı, and Çetin (2011) implemented a science camp; Karaçam (2015) implemented hands-on research activities; and Korkmaz (2011) and Erten, Kıray, and Şen-Gümüş (2013) presented scientists' biographies.

Rationale of This Study

Since 1957, the results of several studies that had been implemented in different grades and countries have shown that students generally define scientists using stereotypes and that students' gender, grade, academic discipline, and socio-economic level are factors that affect their scientist-image. There are conflicting results in studies relevant to the effect of students' culture and socio-economic level. As a result of the studies on socio-economic levels, the images of students in the upper socio-economic levels were stated to be more stereotypical than their counterparts at lower socio-economic levels. Based on this result, the scientist-images of students attending school in the United States, England, France, and so on are expected to be more stereotypical than the scientist-images of their peers attending school in Bolivia, Nigeria, and such because of the difference in socio-economic levels. However, according to the results of studies that have examined the effect of culture, no statistically significant difference has been asserted between students from different cultures (i.e., United States and Bolivia). One of the reasons relevant to this conflict could be the data-analysis approaches that were used in those studies.

In previous studies on examining or revising students' scientist-images; data was analyzed based on the percentage and frequency of all indicators of scientist-image. Each indicator was analyzed by itself. In this study, however, Turkish primary school students' scientist-images are to be analyzed based on the relationships among indicators of scientist-image stereotypes. As this is distinct from previous studies a model of students' scientist-images will be presented. This approach of aiming to construct a model might illustrate the effect of culture on students' scientist-images in more detail and in so doing may remove any conflict between the results of studies relevant to the effect of students' culture and/or socio-economic levels.

In addition, studies that have tried to revise scientist-image stereotypes through approaches such as science camps, inviting scientists to class, visiting scientists, and the like were seen to employ scientists who did not fit the scientist-image stereotypes. Furthermore, some of these studies presented female scientists, while others presented figures working outdoors, wearing a lab coat, and so on. The present study, which examines the relationships among the stereotype indicators, seeks to determine the core indicators. By determining core indicators, this study can guide future studies that aim to revise image stereotypes.

The Question

Are there relationships among the indicators of primary-school students' scientist-image stereotypes?

Purpose

This study aims to determine the relationships among indicators of primary-school students' scientist-image stereotypes.

Method

In this section, the research models, participants, implementation method, data collection techniques, and analysis approaches are represented.

Research Model

The current study has been undertaken to determine the relationships among primary-school students' indicators of stereotypical scientist-images based on the cross-sectional survey study. Cross-sectional surveys involve the collection of data from a single point in time through a sample drawn from a specific population. These surveys are more often used to document the prevalence of particular characteristics in a population (Visser, Krosnick, & Lavrasak, 2000). According to researchers, cross-sectional surveys offer the opportunity to assess the relationships between variables and the differences between subgroups in a population; it can be used to test causal hypotheses in a number of ways. Based on this view, the cross-sectional survey study was used here to determine primary-school students' scientist-image indicators in terms of stereotype.

Participants

A total of 877 students who were attending the sixth and seventh grades of a primary school in Düzce during the 2013-2014 school year participated in this study. The purposeful sampling strategy was used to select participants (Creswell, 2013) for the study. The mission of constructing perceptions towards science and scientists has always been in the realm of science lessons in Turkey. Science classes are provided starting in Grade 3. Science classes are taught by classroom teachers in the third and fourth grades and by teachers from the Science and Technology Department for Grades 5 through 8. Chambers (1983) asserted that by the fifth grade scientist-image stereotypes have been formed. The current study consisted of sixth- and seventh-grade students because these science lessons are taught by science department teachers from Grades 5 through 8 and scientist-image stereotypes have already been formed by the fifth grade. All students attending the sixth and seventh grades participated in the study. Table 1 presents the distribution of students according to gender and class.

Table 1
Frequencies and Percentage Distributions of Participants' Gender and Grade

Grade	Male		Female		Total	
	f	%	f	%	f	%
6	215	24.5	205	23.4	420	47.9
7	223	25.4	234	26.7	457	52.1
Total	438	49.9	439	50.1	877	100

Implementation

The implementation was undertaken during the 2013-2014 academic year. At the beginning of implementation, students were informed about the aims of the study. In addition to the implementation, students were expected to write their demographic information, such as first and last name, grade, and so on. In the second section, students were informed and then asked to draw a scientist at work. Students were also expected to write an essay about the scientist they had drawn after completing their drawings. The drawing section was implemented within 40 minutes.

Data Collection Tools

The Drawing-A-Scientist Test (DAST) was used to determine primary school students' scientist-images. This test was developed by Chambers (1983) and has been used in numerous studies. Students were informed before the DAST implementation that they could use colored pens and pencils in their drawings and that they could also write on their drawings. Students were also told that their drawings would not be examined for accuracy or validity, that they would not be judged for accuracy, and that students were expected to present their visual imageries about scientists in their drawings. Students were asked to provide a written description of their drawing in order to support the analysis. Students were given 40 minutes to complete their drawings.

Data Analysis

In this study, DAST-C (Finson et al., 1995) was used for analyzing the data obtained from DAST. DAST-C consists of 15 indicators of scientist-image stereotypes. These indicators are: lab coat, eyeglasses, facial hair, symbols of research, symbols of knowledge, technology products, relevant captions relevant to these things, male gender, Caucasian, indications of danger, presence of light bulbs, mythical stereotypes, indications of secrecy, working indoors, and middle-aged/elderly scientists. The indicators of presence of light bulbs, mythic stereotypes, and signs of secrecy and danger were excluded from analysis because of their low percentage of occurrence. The indicator of Caucasian was excluded from analysis in case all students presented this indicator. Indicators found in this study that are not normally included in DAST-C were not added to the coding list. For reliability, two different coders analyzed 175 sets of data that had been selected randomly. Their codes were entered into the PASW-18 package program. The relationships between data sets were analyzed using the chi-squared test based on the indicators. A statistically significant positive relationships between codes was found for all indicators that had been determined by the coders. Continuity-correction coefficients between the codes for lab coat; eye glasses; untidy hair; facial hair; symbols of research, knowledge and technology; relevant captions; male; working indoors; aged/middle aged; and working alone were found respectively as $\chi^2 = 43.53$, $\chi^2 = 150.616$, $\chi^2 = 52.882$, $\chi^2 = 119.184$, $\chi^2 = 40.243$, $\chi^2 = 116.778$, $\chi^2 = 46.262$, $\chi^2 = 20.105$, $\chi^2 = 124.570$, $\chi^2 = 65.644$, $\chi^2 = 61.171$, $\chi^2 = 132.259$.

Findings

In this section, we present the findings on the relationship between indicators of scientist-images as represented by primary school students. The finding on the relationships among lab coat and other indicators is represented below. This finding is represented over all of the other indicators. To avoid repetition, findings that had been previously represented are not included in subsequent tables. Thus the number of indicators gradually decreases until the last indicator.

Table 2
Chi-Squared Results on the Relationships of the Lab-Coat Indicator over Other Indicators of Scientist-Image

Indicators	With/Without	Labcoat With f (%)	Labcoat Without f (%)	N	χ^2	Φ	Sd	p
Eyeglasses	With	260 (29.6)	97 (11.1)	877	3.414	0.065	1	0.065
	Without	347 (39.6)	173 (19.7)					
Untidy Hair	With	34 (39.5)	114 (13.0)	877	15.780	0.137	1	0.000*
	Without	261 (29.8)	156 (17.8)					
Facial Hair	With	170 (19.4)	76 (8.7)	877	0.000	-0.001	1	1.000
	Without	437 (49.8)	194 (22.1)					
Symbols of Research	With	546 (62.3)	183 (20.9)	877	63.923	0.273	1	0.000*
	Without	61 (7.0)	87 (9.9)					
Symbols of Knowledge	With	381 (43.4)	140 (16.0)	877	8.787	0.103	1	0.003*
	Without	226 (25.8)	130 (14.8)					
Symbols of Technology	With	279 (31.8)	121 (13.8)	877	0.059	0.011	1	0.809
	Without	328 (37.4)	149 (17.0)					
Relevant Captions	With	111 (12.7)	39 (4.4)	877	1.684	0.047	1	0.194
	Without	496 (56.6)	231 (26.3)					
Male	With	521 (59.4)	217 (24.7)	877	3.780	0.069	1	0.052
	Without	86 (9.8)	53 (6.0)					
Working Alone	With	556 (63.4)	252 (28.7)	877	0.555	-0.030	1	0.456
	Without	51 (5.8)	18 (2.1)					
Aged/Middle Aged	With	528 (60.2)	214 (24.4)	877	7.891	0.099	1	0.005*
	Without	79 (9.0)	56 (6.4)					
Working Indoors	With	587 (66.9)	234 (26.7)	877	29.846	0.190	1	0.000*
	Without	20 (2.3)	36 (4.1)					

*$p < .05$.

According to Table 2, statistically significant relationships were seen between the frequency of students who emphasized the indicators of lab coat and untidy hair ($\chi^2_{(1)} = 15\ 780$, $\Phi = 0.137$, $p < .05$), lab coat and symbols of research ($\chi^2_{(1)} = 63.923$, $\Phi = 0.273$, $p < .05$), lab coat and symbols of knowledge ($\chi^2_{(1)} = 8.787$, $\Phi = 0.103$, $p < .05$), lab coat and aged/middle aged ($\chi^2_{(1)} = 7.891$, $\Phi = 0.099$, $p < .05$), and lab coat and working indoors ($\chi^2_{(1)} = 29.846$, $\Phi = 0.190$, $p < .05$). When the phi coefficients of the indicators were examined, all were seen to be positive. Hence, students who drew their scientist with a lab coat were determined to also have tended to draw their scientist with untidy hair, aged/middle aged, working indoors, and symbols of knowledge and research.

On the other hand, no statistically significant relationships were seen between the frequency of students who had drawn their scientist with a lab coat and eyeglasses ($\chi^2_{(1)} = 3.414$, $p > .05$), lab coat and facial hair ($\chi^2_{(1)} = 0.000$, $p > .05$), lab coat and symbols of technology ($\chi^2_{(1)} = 0.059$, $p > .05$), lab coat and relevant captions ($\chi^2_{(1)} = 1.684$, $p > .05$), lab coat and male ($\chi^2_{(1)} = 3.780$, $p > .05$), or lab coat and working alone ($\chi^2_{(1)} = 0.555$, $p > .05$). Thus, the indicator of lab coat did not reveal a dependence on the indicators of having facial hair, having eyeglasses, being male, symbols of technology, relevant captions, or working alone.

Talha, who drew the picture in Figure 1, explained the scientist he drew as follows:

> The scientist I drew is one who has closed himself into the laboratory, has untidy hair, and doesn't care about himself. He is 50 years old and has never been married. He only thinks about science and works alone in his laboratory. He never takes off his lab coat, even before going to bed. Now he is reading a book and trying to do the immortality elixir with the flammable materials in front of him.

Figure 1. Talha's scientist drawing.

Table 3
Chi-Squared Results on the Relationship of Indicator of Eyeglasses over Other Indicators of Scientist-Image

Indicators	With/Without	Eyeglass With f (%)	Eyeglass Without f (%)	N	χ^2	Φ	Sd	*p*
Untidy Hair	With	204 (23.3)	256 (29.2)	877	5.001	0.078	1	0.025*
	Without	153 (17.4)	264 (30.1)					
Facial Hair	With	118 (13.5)	128 (14.6)	877	7.055	0.092	1	0.008*
	Without	239 (27.3)	392 (44.7)					
Symbols of Research	With	305 (34.8)	424 (48.3)	877	2.021	0.051	1	0.155
	Without	52 (5.9)	96 (10.9)					
Symbols of Knowledge	With	234 (26.7)	287 (32.7)	877	8.986	0.104	1	0.003*
	Without	123 (14.0)	233 (26.6)					
Symbols of Technology	With	173 (19.7)	227 (25.9)	877	1.782	0.047	1	0.182
	Without	184 (21.0)	293 (33.4)					
Relevant Captions	With	64 (7.3)	86 (9.8)	877	0.198	0.018	1	0.656
	Without	293 (33.4)	434 (49.5)					
Male	With	301 (34.3)	437 (49.8)	877	0.000	0.004	1	0.988
	Without	56 (6.4)	83 (9.5)					
Working Alone	With	326 (37.2)	482 (55.0)	877	0.379	-0.025	1	0.538
	Without	31 (3.5)	38 (4.3)					
Aged/Middle Aged	With	318 (36.0)	426 (48.6)	877	6.566	0.090	1	0.010*
	Without	41 (4.7)	94 (10.7)					
Working Indoors	With	343 (39.1)	478 (54.5)	877	5.439	0.083	1	0.020*
	Without	14 (1.6)	42 (4.8)					

*$p < .05$.

As shown in Table 3, statistically significant relationships are found within the frequency of students who had drawn scientist with eyeglasses and untidy hair ($\chi^2_{(1)} = 5.001$, $\Phi = 0.078$, $p < .05$), eyeglasses and facial hair ($\chi^2_{(1)} = 7.055$, $\Phi = 0.092$, $p < .05$), eyeglasses and aged/middle aged ($\chi^2_{(1)} = 6.566$, $\Phi = 0.090$, $p < .05$), eyeglasses and working indoors ($\chi^2_{(1)} = 5.439$, $\Phi = 0.083$, $p < .05$), and eyeglasses and symbols of knowledge ($\chi^2_{(1)} = 8.986$, $\Phi = 0.104$, $p < .05$). On the basis that the calculated phi-coefficients were positive in all chi-squared test results, students who drew their scientist with eyeglasses can be asserted to have tended to draw their scientist as a person with untidy hair and facial hair, as aged/middle aged, working indoors, and using knowledge materials.

Conversely, no statistically significant relationships were found with the frequency of students who had emphasized the indicators of eyeglasses and relevant captions ($\chi^2_{(1)} = 0.198$, $p > .05$), eyeglasses and symbols of research ($\chi^2_{(1)} = 2.021$, $p > .05$), eyeglasses and symbols of technology ($\chi^2_{(1)} = 1.782$, $p > .05$), eyeglasses and male ($\chi^2_{(1)} = 0.000$, $p > .05$, or eyeglasses and working alone ($\chi^2_{(1)} = 0.379$, $p > .05$). From these results, the indicator of eyeglasses can be asserted as independent from the indicators of male, working alone, using research and technological tools, and relevant captions.

Ali, who drew the picture in Figure 2, explained the scientist he drew as follows:

The scientist I drew is a man who works alone at the age of 45. He improves himself by reading books. He reads books so much that his eyes have failed, and his hair and beard are untidy.

Figure 2. Ali's scientist drawing.

Table 4

Chi-Squared Results on the Relationship of the Untidy-Hair Indicator over Other Indicators of Scientist-Image

Indicators	With/Without	Untidy Hair: With f (%)	Untidy Hair: Without f (%)	N	χ^2	Φ	Sd	*p*
Facial Hair	With	156 (17.8)	90 (10.3)	877	15.872	0.137	1	0.000*
	Without	304 (34.7)	327 (37.8)					
Symbols of Research	With	401 (45.7)	59 (6.7)	877	10.711	0.114	1	0.001*
	Without	328 (37.4)	89 (10.1)					
Symbols of Knowledge	With	284 (32.4)	237 (27.0)	877	1.983	0.05	1	0.148
	Without	176 (20.1)	180 (20.5)					
Symbols of Technology	With	212 (24.2)	188 (21.4)	877	0.053	0.01	1	0.818
	Without	248 (28.3)	229 (26.1)					
Relevant Captions	With	85 (9.7)	65 (7.4)	877	1.093	0.038	1	0.296
	Without	375 (42.8)	352 (40.1)					
Male	With	426 (48.6)	312 (35.6)	877	50.567	0.243	1	0.000*
	Without	34 (3.9)	105 (12.0)					
Working Alone	With	430 (49.0)	378 (43.1)	877	2.043	0.053	1	0.153
	Without	30 (3.4)	39 (4.4)					
Aged/Middle Aged	With	404 (46.1)	338 (38.5)	877	7.188	0.094	1	0.007*
	Without	56 (6.4)	79 (9.0)					
Working Indoors	With	440 (50.2)	381 (43.4)	877	6.021	0.088	1	0.014*
	Without	20 (2.3)	36 (4.1)					

*$p < .05$.

According to Table 4, statistically significant relationships are seen between the frequency of students whose drawings included indicators of untidy hair and facial hair ($\chi^2_{(1)} = 15.872$, $\Phi = 0.137$, $p < .05$), untidy hair and symbols of research ($\chi^2_{(1)} = 10.711$, $\Phi = 0.114$, $p < .05$), untidy hair and male ($\chi^2_{(1)} = 50.567$, $\Phi = 0.243$, $p < .05$), untidy hair and aged/middle aged ($\chi^2_{(1)} = 7.188$, $\Phi = 0.094$, $p < .05$), and untidy hair and working indoors ($\chi^2_{(1)} = 6.021$, $\Phi = 0.088$, $p < .05$). When the phi coefficients from the chi-squared test results were examined, all coefficients were found to be positive. Thus, students who drew their scientist with untidy hair can be stated to have tended to emphasize the indicators of facial hair, symbols of research, male, aged/middle aged, and working indoors.

On the other hand, no statistically significant relationships could be stated with the frequency of students who emphasized the indicators of untidy hair and relevant captions ($\chi^2_{(1)} = 1.093$, $p > .05$), untidy hair and symbols of knowledge ($\chi^2_{(1)} = 1.983$, $p > .05$), untidy hair and symbols of technology ($\chi^2_{(1)} = 0.053$, $p > .05$), or untidy hair and working alone ($\chi^2_{(1)} = 2.043$, $p > .05$). Hence, the indicator of untidy hair can be stated to not depend on the indicators of relevant captions, symbols of knowledge, symbols of technology, or working alone.

Table 5

Chi-Squared Results on the Relationship of the Facial-Hair Indicator over Other Indicators of Scientist-Image

Indicators	With/Without	Facial Hair With f (%)	Facial Hair Without f (%)	N	χ^2	Φ	Sd	*p*
Symbols of Research	With	207 (23.6)	522 (59.5)	877	0.163	0.017	1	0.686
	Without	39 (4.4)	109 (12.4)					
Symbols of Knowledge	With	146 (16.6)	375 (42.8)	877	0.000	-0.001	1	1.000
	Without	100 (11.4)	256 (29.2)					
Symbols of Technology	With	106 (12.1)	294 (33.5)	877	0.740	-0.032	1	0.390
	Without	140 (16.0)	337 (38.4)					
Relevant Captions	With	43 (4.9)	107 (12.2)	877	0.007	0.854	1	0.932
	Without	203 (23.1)	524 (59.7)					
Male	With	242 (27.6)	496 (56.6)	877	50.390	0.243	1	0.000*
	Without	4 (0.5)	135 (15.4)					
Working Alone	With	231 (26.3)	577 (65.8)	877	1.158	0.041	1	0.282
	Without	15 (1.7)	54 (6.2)					
Aged/Middle Aged	With	237 (27.0)	505 (57.6)	877	34.910	0.203	1	0.000*
	Without	9 (1.0)	126 (14.4)					
Working Indoors	With	232 (26.5)	589 (67.2)	877	0.138	0.018	1	0.710
	Without	14 (1.6)	42 (4.8)					

*$p < .05$.

According to Table 5, statistically significant relationships can be seen between the frequency of students who emphasized the indicators of facial hair and male ($\chi^2_{(1)} = 50.390$, $\Phi = 0.243$, $p < .05$) and facial hair and aged/middle aged ($\chi^2_{(1)} = 34.910$, $\Phi = 0.203$, $p < .05$). According to the phi coefficient, students who expressed a scientist as a person with facial hair in their drawings can be stated to have tended to emphasize the indicators of male and aged/middle aged.

On the other hand, no relationships were seen between the frequency of students who emphasized in their drawings the indicators of facial hair and symbols of research ($\chi^2_{(1)} = 0.163$, $p > .05$), facial hair and symbols of knowledge ($\chi^2_{(1)} = 0.000$, $p > .05$), facial hair and symbols of technology ($\chi^2_{(1)} = 0.740$, $p > .05$), facial hair and relevant captions ($\chi^2_{(1)} = 0.007$, $p > .05$), facial hair and working alone ($\chi^2_{(1)} = 0.053$, $p > .05$), or facial hair and working indoors ($\chi^2_{(1)} = 0.138$, $p > .05$). According to these findings, the indicator of facial hair can be said to not depend on the indicators of symbols of research, symbols of knowledge, symbols of technology, relevant captions, working alone, or working indoors.

Table 6
Chi-Square Results on the Relationship of Research-Symbols Indicator over Other Indicators of Scientist-Image

Indicators	With/Without	Symbols of Research		N	χ^2	Φ	Sd	*p*
		With	Without					
		f(%)	f(%)					
Symbols of Knowledge	With	439 (50.1)	82 (9.4)	877	0.991	0.037	1	0.319
	Without	290 (33.1)	66 (7.5)					
Symbols of Technology	With	305 (34.8)	95 (10.8)	877	23.882	-0.168	1	0.000*
	Without	424 (48.3)	53 (6.0)					
Relevant Captions	With	135 (15.4)	15 (1.7)	877	5.521	0.083	1	0.019*
	Without	594 (67.7)	133 (15.2)					
Male	With	615 (70.1)	123 (14.0)	877	0.066	0.013	1	0.797
	Without	114 (13.0)	25 (2.9)					
Working Alone	With	668 (76.2)	140 (16.0)	877	1.109	-0.041	1	0.292
	Without	61 (7.0)	8 (0.9)					
Aged/Middle Aged	With	622 (70.9)	120 (13.7)	877	1.389	0.044	1	0.239
	Without	107 (12.2)	28 (3.2)					
Working Indoors	With	708 (80.7)	113 (12.9)	877	85.326	0.318	1	0.000*
	Without	21 (2.4)	35 (4.0)					

*$p < .05$.

In Table 6, statistically significant relationships are seen between the frequency of students who emphasized the indicators of symbols of research and symbols of technology ($\chi^2_{(1)} = 23.882$, $\Phi = -0.168$, $p < .05$), symbols of research and relevant captions ($\chi^2_{(1)} = 5.521$, $\Phi = 0.083$, $p < .05$), and symbols of research and working indoors ($\chi^2_{(1)} = 85.326$, $\Phi = 0.318$, $p < .05$). When the phi coefficients were examined, while the phi coefficients relevant to the indicators of symbols of research and symbols of technology were found to be negative, the phi coefficients relevant to the indicators of symbols of research, Relevant captions, and working indoor could be seen to be positive. On the basis of these phi coefficients, it can be asserted that while students who drew a scientist working with research tools had tended to emphasize the indicators of relevant captions and working indoors, they had tended not to draw a scientist using technological devices.

Conversely, no statistically significant relationships were seen between the frequency of students who had expressed in their drawings the indicators of symbols of research and symbols of knowledge ($\chi^2_{(1)} = 0.991$, $p > .05$), symbols of research and male ($\chi^2_{(1)} = 0.066$, $p > .05$), symbols of research and working alone ($\chi^2_{(1)} = 1.109$, $p > .05$), or symbols of research and aged/middle aged ($\chi^2_{(1)} = 1.389$, $p > .05$). From these findings, the indicator of symbols of research can be stated to not depend on the indicators of symbols of knowledge, male, working alone or aged/middle aged.

İsmail Cem, who drew the picture in Figure 3, explained the scientist he drew as follows:

The scientist I drew is 50 years old. He tries to develop the robot, table and rocket in the picture through experiments. Now he is studying the formula that he has written on the board at the end of the experiment. He is studying alone since he is scared that his invention can be stolen.

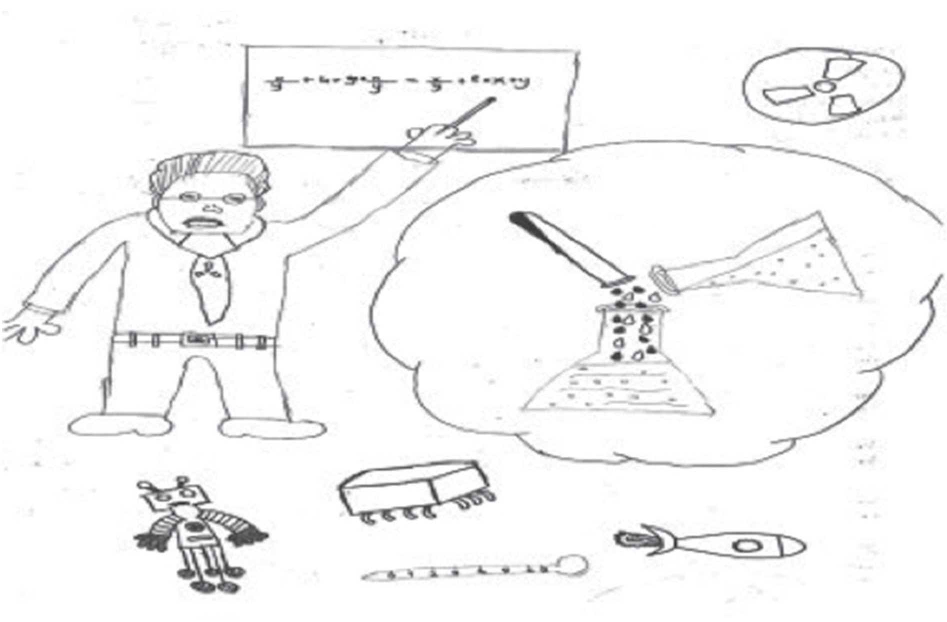

Figure 3. İsmail Cem's scientist drawing.

As can be seen in Table 7, statistically significant relationships exist with the frequency of students who emphasized in their drawings the indicators of symbols of knowledge and Relevant captions ($\chi^2_{(1)} = 30.798$, $\Phi = 0.190$, $p < .05$) and symbols of knowledge and working indoors ($\chi^2_{(1)} = 27.862$, $\Phi = 0.183$, $p < .05$). When examining the phi coefficients relevant to the chi-squared test results, all were seen to be positive. Hence, students who imagined their scientist with knowledge materials like books and notes can be said to have tended to draw scientists as a person engaging in relevant captions and working indoors.

Table 7
Chi-Squared Results Relevant to the Symbols-of-Knowledge Indicator over Other Indicators of Scientist-Image

Indicators	With/Without	Symbols of Knowledge With f (%)	Symbols of Knowledge Without f (%)	N	χ^2	Φ	Sd	*p*
Symbols of Technology	With	242 (27.6)	158 (18.0)	877	0.286	0.020	1	0.593
	Without	279 (31.8)	198 (22.6)					
Relevant Captions	With	120 (13.7)	30 (3.4)	877	30.798	0.190	1	0.000*
	Without	401 (45.7)	326 (37.2)					
Male	With	433 (49.4)	305 (34.8)	877	0.860	-0.034	1	0.354
	Without	88 (10.0)	51 (5.8)					
Working Alone	With	486 (55.4)	322 (36.7)	877	1.967	0.052	1	0.161
	Without	35 (4.0)	34 (3.9)					
Aged/Middle Aged	With	446 (50.9)	296 (33.8)	877	0.802	0.033	1	0.371
	Without	75 (8.6)	60 (6.8)					
Working Indoors	With	507 (57.8)	314 (35.8)	877	27.862	0.183	1	0.000*
	Without	14 (1.6)	42 (4.8)					

*$p < .05$.

On the other hand, no statistically significant relationships were found between the frequency of students who had expressed in their drawings the indicators of symbols of knowledge and symbols of technology ($\chi^2_{(1)}$= 0.286, $p > .05$), symbols of knowledge and male ($\chi^2_{(1)}$= 0.860, $p > .05$), symbols of knowledge and working alone ($\chi^2_{(1)}$= 1.967, $p > .05$), or symbols of knowledge and aged/middle aged ($\chi^2_{(1)}$= 0.802, $p > .05$). Thus, the indicator of symbols of knowledge can be asserted to not depend on the indicators of symbols of technology, male, working alone, or aged/middle aged.

Table 8
Chi-Squared Results Relevant to the Symbols-of-Technology Indicator over Other Indicators of Scientist-Image

Indicators	With/Without	Symbols of Technology With f (%)	Symbols of Technology Without f (%)	N	χ^2	Φ	Sd	*p*
Relevant Captions	With	77 (8.8)	73 (8.3)	877	2.199	0.052	1	0.145
	Without	323 (36.8)	404 (46.1)					
Male	With	336 (38.3)	402 (45.8)	877	0.000	-0.004	1	0.985
	Without	64 (7.3)	75 (8.6)					
Working Alone	With	360 (41.0)	448 (51.1)	877	4.088	-0.073	1	0.043*
	Without	40 (4.6)	29 (3.3)					
Aged/Middle Aged	With	335 (38.2)	407 (46.4)	877	0.302	-0.022	1	0.582
	Without	65 (7.4)	70 (8.0)					
Working Indoors	With	377 (43.0)	444 (50.6)	877	0.321	0.024	1	0.571
	Without	23 (2.6)	33 (3.9)					

*$p < .05$.

According to Table 8, a statistically significant relationship can be seen between the frequency of students who drew their scientist with the indicators of technological device and working alone ($\chi^2_{(1)}$= 4.088, Φ= -0.073, $p < .05$). Based on finding the phi coefficient relevant to this relationship to be negative, students who drew their scientist using a technological device can be asserted to have tended not to imagine scientists as working alone.

On the other hand, no statistically significant relationships were seen between the frequency of students who had emphasized in their drawings the indicators of symbols of technology and relevant captions ($\chi^2_{(1)} = 2.199$, $p > .05$), symbols of technology and male ($\chi^2_{(1)} = 0.000$, $p > .05$), symbols of technology and aged/middle aged ($\chi^2_{(1)} = 0.302$, $p > .05$), or symbols of technology and working indoors ($\chi^2_{(1)} = 0.321$, $p > .05$). Thus the indicator of symbols of technology can be stated to not depend on the indicators of relevant captions, male, aged/middle aged, or working indoors.

Table 9
Chi-Squared Results Relevant to the Indicator of Relevant Captions over Other Indicators of the Scientist-Image

Indicators	With/Without	Relevant Captions With f (%)	Relevant Captions Without f (%)	N	χ^2	Φ	Sd	p
Male	With	131 (14.9)	607 (69.2)	877	1.102	0.040	1	0.294
	Without	19 (2.2)	120 (13.7)					
Working Alone	With	135 (15.4)	673 (76.7)	877	0.808	-0.036	1	0.369
	Without	15 (1.7)	54 (6.2)					
Aged/Middle Aged	With	132 (15.1)	610 (69.6)	877	1.301	0.043	1	0.254
	Without	18 (2.1)	117 (13.3)					
Working Indoors	With	146 (16.6)	675 (77.0)	877	3.469	0.069	1	0.063
	Without	4 (0.5)	52 (5.9)					

*$p < .05$.

In Table 9, no statistically significant relationship can be seen between the frequency of students who emphasized in their drawings the indicators of relevant captions and male ($\chi^2_{(1)} = 1.102$, $p > .05$), relevant captions and working alone ($\chi^2_{(1)} = 0.808$, $p > .05$), relevant captions and aged/middle aged ($\chi^2_{(1)} = 1.301$, $p > .05$), and relevant captions and working indoors ($\chi^2_{(1)} = 3.469$, $p > .05$). Hence, the indicator of relevant captions can be purported to not depend on the indicators of male, working alone, aged/middle aged, or working indoors.

Table 10
Chi-Squared Results Relevant to the Indicator of Male over Other Indicators of the Scientist-Image

Indicators	With/Without	Male With f (%)	Male Without f (%)	N	χ^2	Φ	Sd	p
Working Alone	With	688 (78.4)	120 (13.7)	877	6.748	0.094	1	0.009*
	Without	50 (5.7)	19 (2.2)					
Aged/Middle Aged	With	638 (72.7)	104 (11.9)	877	11.271	0.118	1	0.001*
	Without	100 (11.4)	35 (4.0)					
Working Indoors	With	690 (78.7)	131 (14.9)	877	0.020	-0.011	1	0.887
	Without	48 (5.5)	8 (0.9)					

*$p < .05$.

In Table 10, statistically significant relationships can be seen between the frequency of students who imagined their scientist with the indicators of male and working alone ($\chi^2_{(1)} = 6.748$, $\Phi = 0.094$, $p < .05$) and male and aged/middle aged ($\chi^2_{(1)} = 11.271$, $\Phi = 0.118$, $p < .05$). When the phi coefficients were examined, all phi coefficients obtained from the chi-squared test were seen to be positive. Hence, students who drew their scientist as male can also be asserted to have tended to draw the scientist as aged/middle aged and as working alone.

Conversely, no statistically significant relationship was seen between the frequency of students who had drawn their scientist as male and as working indoors ($\chi^2_{(1)} = 0.020$, $p > .05$). According to this finding, the indicator of male can be said to not depend on the indicator of working indoors.

Table 11

Chi-Squared Results Relevant to the Indicator of Working Alone over Other Indicators of the Scientist-Image

Indicators	With/Without	Working Alone		N	χ^2	Φ	Sd	p
		With	Without					
		f (%)	f (%)					
Aged/Middle Aged	With	690 (78.7)	52 (5.9)	877	4.174	0.075	1	0.041*
	Without	118 (13.5)	17 (1.9)					
Working Indoors	With	758 (86.4)	63 (7.2)	877	0.315	0.028	1	0.437
	Without	50 (5.7)	6 (0.7)					

*$p < .05$.

As can be seen in Table 11, a statistically significant relationship exists between the frequency of students who had drawn their scientist as working alone and as aged/middle aged ($\chi^2_{(1)} = 4.174$, $\Phi = 0.075$, $p < .05$). Because of the positive phi coefficient, students who drew their scientist working alone can be said to have tended to draw scientists as aged/middle aged.

On the other hand, no statistically significant relationship was seen to exist between the frequency of students who had drawn their scientist as working alone and as working indoors ($\chi^2_{(1)} = 0.315$, $p > .05$). So the indicator of working alone can be stated to not depend on the indicator of working indoors.

Table 12

Chi-Squared Results Relevant to the Scientist-Image Indicators of Aged/Middle Aged and Working Indoors

Indicators	With/Without	Aged/Middle Aged		N	χ^2	Φ	Sd	p
		With	Without					
		f (%)	f (%)					
Working Indoors	With	699 (79.7)	122 (13.9)	877	2.205	0.057	1	0.138
	Without	43 (4.9)	13 (1.5)					

*$p < .05$.

According to Table 11, no statistically significant relationship was seen between the frequency of students who drew their scientist as aged/middle aged and as working indoors ($\chi^2_{(1)} = 2.205$, $p > .05$). So the indicator of aged/middle aged can be stated to not depend on the indicator of working indoors.

Discussion

This study has examined the relationships among indicators of Turkish primary school students' scientist-image stereotypes. As a result of this study, some relationships were found to exist among indicators, as represented in Figure 4 below.

According to these relationships among indicators, students can be asserted to have different tendencies towards scientist-images based on indicator stereotypes. Those tendencies are represented as follows:

- Students who defined scientists as wearing untidy hair generally drew a scientist with facial hair, wearing a lab coat and eyeglasses, working indoors with research tools, and as an aged/middle aged male.
- Students who defined scientists as aged/middle-aged generally represented scientists as a male working alone, with facial hair and untidy hair, and wearing a lab coat and eyeglasses.
- Students who defined a scientist as someone wearing a lab coat generally represented scientists as aged/middle-aged with untidy hair working indoors in a laboratory with research tools and/or knowledge materials.
- Students who represented a scientist as someone working with research tools generally defined scientists as wearing a lab coat, with untidy hair, working indoors, dealing with relevant captions like formulas, but without a technological device.
- Students who defined a scientist as someone working indoors generally represented scientists wearing a lab coat and eyeglasses with untidy hair and working with research tools and/or knowledge materials.
- Students who drew a scientist wearing eyeglasses generally represented scientists as aged/middle-aged with untidy hair, with facial hair, and working indoors with knowledge materials.
- Students who defined a scientist as male generally represented scientists as aged/middle-aged, working alone, with facial hair, and with untidy hair.
- Students who drew scientists with facial hair generally represented scientists as an aged/middle-aged male with untidy hair and glasses.

- Students who defined a scientist as a person working alone generally represented scientists as an aged/middle-aged male working with devices that are not technological.
- Students who defined a scientist as a person working with knowledge materials generally represented scientists wearing eyeglasses, working indoors, and dealing with relevant captions.
- Students who drew a scientist as a person working with technological devices generally represented scientists working in a group and working with devices other than research tools.
- Students who defined a scientist as a person that deals with relevant captions generally represented scientists working with research tools and/or knowledge materials.

The results of this study show that students have different tendencies towards scientist-image stereotypes based on the relationships among indicator stereotypes. However, in most previous studies (Barman, 1999; Bowtell, 1996; Chambers, 1983; Medina-Jerez et al. 2011; Milford & Tippett, 2013) conducted in terms of grade school, students were stated to have scientist-image stereotypes. According to these studies, because media and textbooks all over the world contain scientific figures illustrating stereotypical images, students are forced to construct this image through these materials (She, 1998). Moreover, based on She's assumption, the results of studies (Chambers, 1983; Ruiz-Mallen & Escallas, 2012) examining the effect of students' socio-economic levels on their scientist-image stated that scientist-images from students in high economic levels are more stereotypical than their peers at lower socio-economic levels due to the differences in their exposure to the media. On the other hand, the results of studies that examined the effect of culture, have shown no difference among students from different cultures and countries, such as Bolivia and the United States (Manabu, 2002), even though these students were not in the same socio-economic levels. As can be seen in those studies, the results are conflicting for studies that examined the effects on students' scientist-images of their culture and socio-economic levels. This conflict might result from the data analysis approaches that had been applied in these studies. In the current approach of data analysis, each indicator was examined within itself. For instance, when one compares the scientist-images of Turkish and Bolivian students, the percentages (or frequencies) of the 12 scientist-images stereotype indicators from the Turkish and Bolivian students are compared separately. Instead of this approach, the data analysis method based on examining the relationships among indicator stereotypes enables researchers to discover students' image schemata in more detail. Thus, researchers might show students' scientist-images and the effects of individual differences such as gender, culture, and so on by

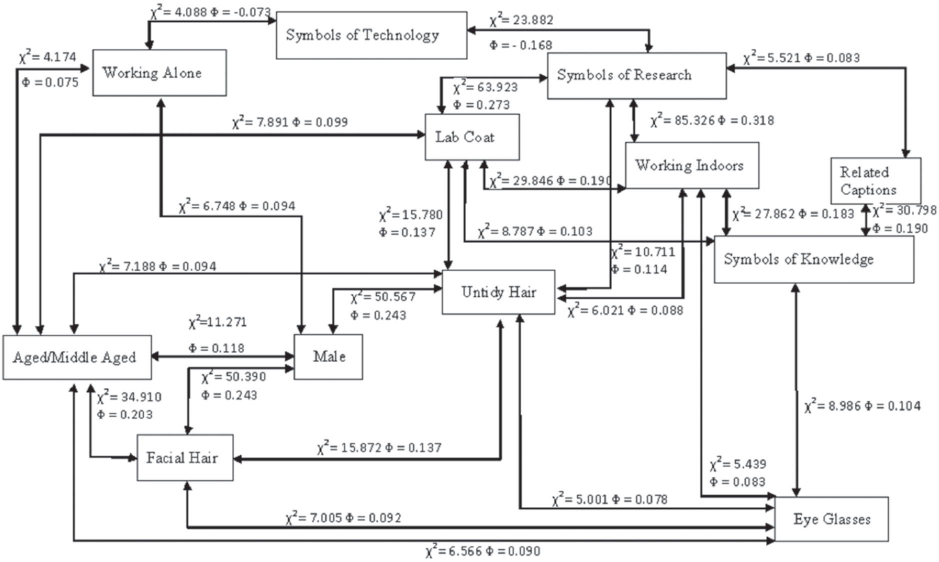

Figure 4. The relationships among indicators of stereotype scientist images of Turkish primary school students.

The previous studies, which tried to revise scientist-image stereotypes through approaches such as science camps, inviting scientists to teaching environments, visiting scientist, and more, had employed scientist figures that did not fit scientist-image stereotypes. Furthermore, some of these studies employed female scientist figures, while others employed figures working outdoors, wearing a lab coat, and so on. According to the model presented in Figure 4, scientist-images of students who defined a scientist as a person with untidy hair were more stereotyped because there were more relationships between the indicator of untidy hair and other indicators. On the other hand, scientist-images of students who defined a scientist as a person working with technological devices or dealing with relevant captions were the least stereotyped due to having the lowest percentage of relationships. Thus it can be asserted that the indicator of untidy hair is a core indicator that should be emphasized in studies that intend to revise scientist-image stereotypes in Turkey. Additionally, studies to determine the core indicators of students from different education levels in Turkey and other countries should be carried out.

In conclusion, this study provides new approaches for determining and revising students' scientist-images and for examining the effects of students' individual differences on images. This approach has some limitations. One of them is the size of the group that participated in this study. This approach cannot be applied to small groups because of the principles of the chi-squared test. Another limitation is participants' grade level. The approach used in this study was to determine primary school students' scientist-images. Should it be used at different grade levels? This is an ambiguous question [sic] because of the age that stereotypical images are accepted as being already formed.

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