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A Scale Development Study: Scientist Image, Gender of the Scientist and Risks of being Scientist*

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ABSTRACT

The aim of this study is to develop a scale to determine the scientist image of high school students and their perceptions of scientist's gender and the risks they have. Descriptive survey model, one of the quantitative research techniques, was used in the study. 760 10th grade students participated in the study. The study was conducted in the spring semester of 2018-2019 academic years. In data collection, item pools were created for the following draft scales developed by researches: (1) "Scientist in Images Scale (ImSca)" to determine students' images of scientists, (2) "Scale for the Perception of Scientist's Gender (GenSca)" to determine students' perceptions of scientist's gender; and (3) "Scale for the Perception of the Risks that Scientist has (RiskSca)" to determine students' perceptions about the risks that scientists have. The construct validity of the scales was determined by using exploratory factor analysis on the data obtained from the scales and reliability of the scales was determined through internal consistency coefficients. As a result of the data analysis, the following structures were formed: ImSca has a 26-item structure with 8 factors, GenSca has a 23-item structure with 3 factors, and RiskSca has a 27-item structure with 6 factors. According to the results of confirmatory factor analyses, the structure of all three scales formed within the scope of the study was confirmed.

Keywords:
Scientist image, perception of the risks of scientist, perception of the gender of scientist

1. Introduction

Since the science is a product of the creativity and imagination of the people, humankind is the sole power in the progress of science. In science, the product produced by human creativity and imagination is scientific knowledge. From this perspective, scientific knowledge is the product of the culture that dominates the world of science. Science culture, on the other hand, is not the product of neither pure eastern, nor pure western culture. It contains a core from the cultures of all societies. If science had been the product of the culture of a single society or a group, alternative paradigms could not be derived in science. In this case, paradigms could not compete, and the process of generating a new paradigm would be slow. In this respect, in order for science to progress, people from different cultures should enter the world of science and bring their paradigms there. However, there are many factors that negatively affect individuals from different cultures to become scientists. One of them is the scientist image that individuals have. The studies examining the scientist images of individuals emphasized that individuals even at different age groups, generally perceive the scientist as a white race man.In the literature, this image that individuals have for the scientist is defined as "stereotyped scientist image" and this image is suggested to negatively affect the science career of females and individuals of non-white race (She, 1998). One of the main components of stereotyped scientist image is the perception of

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the gender of the scientist. It is stated that the individuals' perception of the gender of the scientist is based on social gender perception (culture of the society), males being presented in written and visual media as scientist figures and addressing scientists as a "man of science" in the language of speech (Karaçam, Aydın & Digilli-Baran, 2014; Karaçam & Digilli-Baran, 2017; Nuhoğlu & Afacan, 2011). It is stated that individuals who have traditional (patriarchal) culture think that the scientist should be male because the scientist should be strong, durable and agile (Karaçam & Digilli-Baran, 2017). This cultural background negatively affects girls' career in science. Another factor affecting individuals' career in science is the perception of individuals about the risks that the scientist has. Although there are limited number studies addressing this perception, it is stated that individuals think that scientists have psychological risks such as madness; sociological risks such as exclusion from society, not being able to get married; labor-oriented risks such as theft of their product; economic risks such as losing all their assets; and life-threatening risks such as assassination, injury or loss of life due to explosion (Digilli-Baran & Karaçam, 2020).

In the above studies, where a summary of the scientist image, perception of the gender of scientist and perception of the risks that scientist has was presented, usually drawing and semi-structured interviews were used to determine these perceptions. These approaches reduce the number of individuals that can be accessed to take opinions. In this regard, to be able to get the perceptions of a broader audience, the validity and reliability study of the scales developed for the variables specified in this research will be discussed.

1.1. Studies to Determine the Scientist Image

Idea in mind is defined in the Turkish Language Association (TLA) dictionary as "objects and events perceived by the senses, appearing in consciousness without any stimulus, imagination, and image". Image is defined in the TLA dictionary as "Objects and events perceived by the senses, appearing in consciousness without a stimulus, general appearance, impression". Since idea in mind and image are synonyms, both words can be used interchangeably in the researches. The pictures formed in our minds when we hear the name of a certain concept or when we think about it is the image we create about the concept. For example, the image that an individual has about the iron atom is that the iron atom is composed of nucleus and electrons, and the shape and size of the structure formed by these atoms coming together (Atasoy, 2004). Images are separated as audio, taste, visual etc... These images have existed since the infancy of humankind and form the basis of the concepts (Mandler, 1992). In other words, our image scheme is the basis of our conceptual framework. In this regard, when the cognitive structures of individuals about a certain concept are addressed in the literature, the images that individuals have about that concept are also used. In this context, many studies examined the images that individuals have about various concepts such as atom, chemical bond, buoyancy force. Another concept in which the images of individuals are examined is the concept of scientist image.

The first study to determine the scientist images of individuals was conducted by Mead and Metraux (1957). Mead and Metraux collected the opinions of individuals with an Essay type measurement tool, and concluded that individuals have a stereotypical scientist image, described as a man wearing a white coat, with glasses, with a mustache, working in a laboratory surrounded by chemical materials and tools, crying as "Eureka, Eureka", reading books and taking notes. From Mead and Metraux (1957) to Chambers (1983) many studies (Beardslee & O'Dowd, 1961; Krajkovich & Smith 1982) have been conducted in various countries using semantic difference scales, Likert type scales and Essay. Likert type and semantic difference scales used in these studies have been developed on the basis of the theory suggested by Mead and Metraux (1957), thus similar results have been obtained, but they allowed working on larger samples.

Chambers (1983) developed a new perspective on the studies on scientist image by showing an alternative approach to Essay type data collection tools. Chambers (1983) developed the "Draw a Scientist Test Coding List", which includes seven indicators of stereotypical scientist image for encoding the data obtained from "Draw a Scientist Test (DAST)". In the coding list that he developed, Chambers covered lab coat, glasses, facial hair like beard/mustache, knowledge symbols like book/notebook; research symbols such as volumetric flask/test tubes; technology symbols such as robot/time machine; and relevant captions like equations/chemical formulas as the indicators of stereotypical scientist image. Finson, Beaver, and Cramond (1995), added eight more indicators to the coding list developed by Chambers (1983), which they suggested as indicators of stereotype science image. These are working environment (indoor), gender (male), age (middle-aged/old), working alone, symbols of danger, secrecy symbols, thought bubbles (bulb) and race (from white race). Many studies (Barman, 1999; Fung, 2002; Newton & Newton, 1992; Ruiz-Mallen & Escalas, 2012) have been conducted to examine the scientist images of individuals in different countries and at different levels of education by using this coding list. Trash and dustbin were added by Karaçam, Bilir and Digilli-Baran (2018) to the lists developed by Chambers (1983) and Finson et al. (1995) as indicators of the stereotype scientist image.

Although DAST, developed by Chambers (1983), is quite popular in the studies conducted to determine the scientist image of individuals in the literature, it should be noted that some studies employed different measurement tools, in which semi-structured interview (Palmer, 1997; Parsons, 1997), word association test (Bovina & Dragul'skai, 2008) and metaphor (Karaçam, 2015) were used as measurement tools. These studies, in which different approaches than DAST were used, reached more detailed results such as the scientist's position in the society, cognitive, affective and psychomotor competencies in addition to the results such as scientist's appearance and working environment. In this regard, the image that individuals have was more detailed in these studies and it was observed that the image of individuals did not fall within the borders drawn by DAST. For this reason, in the recent studies (Milford and Tippett, 2013; Schrez and Oren, 2007), some measurement approaches such as Likert type scales, DAST, semi-structured interview, word association test, metaphor were employed in the data collection process. However, the items of the Likert type scales used in these studies targeted the external appearance, working environment, gender and age of the scientist based on the theoretical framework drawn by DAST. In other words, regarding the Likert type scales used in the literature, they kept the basis of the theoretical ground established by DAST although the theoretical ground was improved. In this regard, in this study we tried to develop a Likert type scale that is based on the new theoretical basis expanded as a result of the studies in which other measurement approaches than DAST were employed.

1.2. Studies about the Gender of the Scientist

One of the most basic indicators of the stereotypical scientist image that was first introduced by Mead and Metraux (1957) is male. In the following years, the studies conducted in various countries and education levels (Barman, 1999; Karaçam, 2015; Koren & Bar, 2009; Milford & Tippett, 2013; Monhardt, 2003) concluded that the majority of individuals perceive the scientist as a man. Makarova, Aeschlimann and Herzog (2019) investigated the perceptions of secondary school students towards the gender of scientists working in mathematics, physics and chemistry, and the effect of their perception on their career in these areas. As a result of the study, it has been reported that students associated male scientist with the fields of physics and chemistry, but they mostly associate it with the field of mathematics and that this association negatively affects the tendency of female students to pursue a career in these fields.

In this context, studies have been initiated to determine the origins of the male scientist image and to revise this image positively, since the perception of male scientist affects girls' career in science negatively and the tendency to have a career in science is low in the United States and European countries. In the study of Karaçam, Aydın and Digilli (2014), who think that the origin of stereotypical perceptions of the scientist may stem from textbooks, the images of scientists in textbooks were examined and they reached the conclusion that the indicator of male scientist is prevalent in the textbooks, as the other stereotypical expressions.

Unlike all these studies, Karaçam and Digilli-Baran (2017) have worked on the origins of this gender-oriented perception of these stereotypical scientist characteristics in students. The researchers, who conducted their research both with a questionnaire consisting of open-ended questions and semi-structured interview, found that many factors affected the students as the origin of stereotypes for the gender of the scientist. Among them they emphasized the use of the term "man of science", which is used to define scientists in society, scientist figures presented in written and visual media, and students' cultural infrastructure. It was found that different ideas were suggested about the gender of the scientist, especially because of the different cultural infrastructures from which the students came. Accordingly; students carrying traditional culture thought that the scientist is male; those who adapted the stereotypical woman in society thought that the scientist is a woman; students who embraced the western culture thought that the scientist may be either a woman or a man.

On the other hand, unlike all these studies, Özdeş and Aslan (2019) examined the perceptions of only female students towards the gender of the scientist and the factors affecting female students' tendency to become scientists as a profession. Özdeş and Aslan (2019), who use phenomenology, which is one of the qualitative research methods, conducted their research with 377 secondary school female students. As a result, they reported that the image of male scientist is at the forefront, but there are also students who draw female scientist. They have found that people who thought of the gender of the scientists as men were especially affected by visual media and written sources; whereas those who drew female scientists drew it due to "the reaction to traditional gender patterns and the desire to become scientists in the future". Moreover, contrary to the literature, it was found that female students draw male scientists not because they don't want to be scientist, but because of having different interests, the way that their teachers presented the scientist, their negative attitude or negative self-perception and especially their safety anxiety towards scientists. Digilli-Baran and Karaçam (in print) named the security concern mentioned here as "risk" for scientists.

1.3. Studies on the Perception of the Risks that Scientist has

TLA (2019) defined the term stereotype as unchanging, non-specific, repeating the known ones. Risk is defined as the danger of getting harm (TLA, 2019). So, stereotypical risk, may mean the danger potential that has been considered to be true for a long time, that remained unchanged. However, like the changeable nature of science and scientific knowledge, the risks that scientists face also change with the change of the living conditions. So why students' perception of the risk that scientist has remained unchanged? The study conducted by Digilli-Baran and Karaçam (2020) in our country revealed the perceptions of secondary school students towards the risks that scientists are exposed to. Phenomenology, a qualitative research method, was used in the research, and the common meanings that secondary school students attributed to the risk phenomenon were determined. 592 secondary school students, 294 girls and 298 boys, participated in the study, of which 1115 risk statements were identified. As a result of the data analysis, the risks themes were created from the risk statements, namely affecting the environment and society; towards the tools and subjects; and affecting the scientist. It was found from these themes that approximately 90% of students have physical, sociological, psychological, labor oriented and economic risk perceptions of the scientist.

The study on the risks that the scientist may have revealed that middle school students emphasized physical risks the most and they mostly emphasized the risk of injury or death as a result of explosion as the physical risk (Digilli-Baran & Karaçam, 2020). The existence of such a result reminds the risks that scientists working centuries ago have been exposed to. Similarly, there are stereotyped risks in other themes. It was found that students emphasized the risk of losing the assets as a result of the explosion as an economic risk; getting away from the society or not being able to marry as sociological risks; failure to reach a result as a risk to labor; and risk of going mad from hard work as a psychological risk. The researchers stated that students perceive the scientist as a hero rather than a normal person, thinking that this fact may be due to the students' poor understanding of the nature of science, or that they may have acquired stereotyped scientist images. As expressed by Archer et al. (2010) and Venville et al. (2013) in the literature, on one hand the real science evokes the danger, and on the other hand the science in the school evokes safe science that is considered to be apart from the real science, which again suggests that the basis of this perception may be stereotypical thoughts.

1.4. The Role of the Study in the Literature

Regarding the objectives of the curriculum published for the science course by the Ministry of National Education (2006; 2013; 2018, a special emphasis was put on encouraging students to pursue a career in science. The most important obstacle for individuals to have a career in science is the image of the scientist they have. In the literature, it is emphasized that the stereotypical image of the scientists that individuals have negatively affects their tendency to have a career in science. It is obvious that the most important obstacle in achieving the stated purpose of the program is the stereotyped scientist image of the students. However, on the basis of this image, students also have a perception regarding the gender of the scientist and the risks they have. Therefore, it can be thought that individuals' perceptions of the gender and risks of the scientist will also affect their career tendency in science.

Regarding the studies on the image of the scientist, the gender of the scientist and the risks that scientist has in the literature, it should be noted that DAST was generally used in the studies determining the scientist image of the individuals, whereas a small number of researches using Likert type scales were encountered. In addition, it should be noted that the Likert-type scales used in the researches were developed within the framework of the working environment or the appearances of the scientist, which were generally addressed in DAST. In this regard, in this study we developed a scale that considers cognitive and social characteristics of the scientist revealed in studies. There is no scale in the literature determining the perceptions of individuals about the gender of the scientist and the risks that they have. In this context, it is expected that the scales to be developed in this study will determine the perceptions of the individuals about the scientist, especially the image of the scientist, and the perceptions of their gender and risks that they have, which restrains individuals' from making a career in the fields of science and guiding the studies for revising the erroneous perceptions of the individuals.

The purpose of this study is to develop scales for determining the scientist image of high school students and their perceptions of scientist's gender and the risks they have.

2. Method

2.1. Research Model

In this study aiming to develop a scale for determining the scientist image of high school students and their perceptions of scientist's gender and the risks they have, survey design was used.

2.2. Participants

Within the scope of the study, data was collected from 760 high school students and the demographic characteristics of the participants are shown in Table 1.

Table 1. Demographic data of the participant group

		N	%
	Female	406	53.4
Gender	Male	354	46.6
	Total	760	100
Table 1 is continued			
	Science High School	84	11.1
	Anatolian High School	374	49.2
School type	Social Science High School	80	10.5
	Religious Vocational High School	61	8.0
	Trade High School	161	21.2
	Total	760	100

In the second stage, more data was collected from 385 high school students to verify the scale structures.

2.3. Data Collection Tools

In this study, which aims to develop scales for determining students' perceptions of scientists, draft scales were created first. These draft scales were designed to determine the scientist's images of high school students, their thoughts on the risks that scientists have, and their perceptions of scientist's gender. These scales were respectively named as "ImSca", "RiskSca" and "GenSca".

The process of creating draft scales is described below, and the following steps were followed while developing the scales.

2.4. Writing scale items

In order to determine students' perceptions of scientists, firstly, domestic and foreign literature was reviewed, and a pool of items was created by compiling the items derived from the researchers' experiences. A 53-item pool was created for ImSca, 76-item pool for RiskSca, and 47-item pool for GenSca. These item pools were reviewed by the researchers, and incomprehensible items, items thought to be unrelated to the scale, and items repeating the content of other items were corrected or removed from the scale. As a result of this elimination and correction, 49 items were kept for ImSca, 58 items for RiskSca, and 42 items for GenSca, and these scales were sent to the Turkish linguistics specialist who examined them in terms of language and expression. The items were revised according to the language specialist's feedback, and the scale items were made ready for expert opinion.

2.5. Expert opinion and content validity

The expert opinion form created by considering the purpose of the scales was arranged in such a way that the experts can express their opinions about each item. Expert Opinion Forms created for each scale were sent to two experts in field of research methods and measurement, science education and educational sciences and the experts were asked to read each item, evaluate them according to the purpose of the scale and in terms of suitability as scale items, and indicate their suggestions, if any. Based on expert opinions, the scales were revised and a draft form consisting of 46 items for ImSca, 56 items for RiskSca and 38 items for GenSca was obtained.

Table 2. Change in the number of scale items

Scales	Number of items in the first item pool	Number of items after the consensus of the researchers	Number of items after Expert Opinion
ImSca	53	49	46
RiskSca	76	58	56
GenSca	47	42	38

The draft forms of the scales have five-point Likert type rating with totally disagree (1), disagree (2), moderately agree (3), agree (4), totally agree (5) options.

2.6. Data Analysis

The data obtained from the answers of the volunteer high school students on the scale items were first transferred to the computer environment. In the study, exploratory factor analysis was used for the factor analysis of the scales; Cronbach Alpha internal consistency coefficient was used for internal consistency study; and correlation analysis was used for revealing the relationships between scale factors.

3. Findings

3.1. Findings for the Validity-Reliability of ImSca

Factor analysis was conducted first to determine the compatibility and structure validity between the items. The results of the test performed to check the suitability of the data obtained from the 46-item scale for factor analysis are shown in Table 3.

Table 3. KMO and Bartlett Test Results for ImSca

Kaiser-Meyer-Olkin Sample Sufficiency		.87
Bartlett Sphericity Test	Chi-square Value	8248.42
	Degree of Freedom	1035
	P	.00

KMO (.87) and Bartlett sphericity (8248.42, $p < .01$) values obtained from the principal component analysis show that the data distribution of the sample is appropriate for factor analysis (Tavşancıl, 2010). Therefore, it can be said that the data come from a multivariate normal distribution.

In this study, basic components analysis and vertical rotation technique were used for exploratory factor analysis. The eigenvalues of the factors and the scree plot were examined together to determine the number of factors in the scale. According to the results of exploratory factor analysis, the threshold was set as .30 while determining the items to be grouped under a factor. In parallel, the items with factor loads below .30 and the items with a load difference below .10 for at least two factors were not assigned to any factors. In this context, 20 items that do not meet these criteria were excluded from the scale and they were not included in the remaining analyzes. As a result of the analysis repeated by removing these items, the scale items were observed to be grouped under 8 factors with an eigenvalue greater than 1.00. The eigenvalues of the factors and the total explained variance of the scale after the last exploratory factor analysis are given in Table 4.

Table 4. Total amount of explained variance for ImSca

	Factor Eigenvalues		
Factors	**Eigenvalues**	**Explained Variance (%)**	**Accumulated Explained Variance (%)**
1	4.00	15.40	15.40
2	3.27	12.58	27.98
3	1.39	5.35	33.33
4	1.29	4.95	38.28
5	1.19	4.58	42.86
6	1.10	4.25	47.11
7	1.06	4.08	51.19
8	1.04	4.00	55.19

Regarding the amount of total explained variance, it is seen that the scale has an eight-factor structure and the total variance amount explained by these eight factors is 55.19%. The results of exploratory factor analysis performed to determine the distribution of the items among the factors are shown in Table 5.

Table 5. Rotated Components Matrix after Exploratory Factor Analysis for ImSca

Factors	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Items	**Factor Load**	**Factor Load**	**Factor Load**	**Factor Load**	**Factor Load**	**Factor Load**	**Factor Load**	**Factor Load**
Item 41	.72	-	-	-	-	-	-	-
Item 12	.68	-	-	-	-	-	-	-
Item 42	.62	-	-	-	-	-	-	-
Item 38	.56	-	-	-	-	-	-	-
Item 4	.46	-	-	-	-	-	-	-
Item 11	-	.71	-	-	-	-	-	-
Item 7	-	.65	-	-	-	-	-	-
Item 25	-	.60	-	-	-	-	-	-
Item 9	-	.59	-	-	-	-	-	-
Item 24	-	.40	-	-	-	-	-	-
Item 37	-	-	.72	-	-	-	-	-
Item 30	-	-	.66	-	-	-	-	-
Item 39	-	-	.66	-	-	-	-	-
Item 45	-	-	.46	-	-	-	-	-
Item 5	-	-	-	.73	-	-	-	-
Item 10	-	-	-	.71	-	-	-	-

Item 14	-	-	-	-	.71	-	-	-
Item 13	-	-	-	-	.67	-	-	-
Item 6	-	-	-	-	.55	-	-	-
Item 3	-	-	-	-	-	.66	-	-
Item 27	-	-	-	-	-	.66	-	-
Item 26	-	-	-	-	-	.64	-	-
Item 15	-	-	-	-	-	-	-.71	-
Item 2	-	-	-	-	-	-	.65	-
Item 18	-	-	-	-	-	-	-	.76
Item 20	-	-	-	-	-	-	-	.68
Eigenvalue	4.00	3.27	1.39	1.29	1.19	1.10	1.06	1.04
Explained Variance	15.40	12.58	5.35	4.95	4.58	4.25	4.08	4.00

According to Table 5, the loads of the items grouped under 8 factors vary between .40 and .76. The factors were named as follows, according to the items they contain: the first factor masculine, the second factor working for society, the third factor meticulous/creative, the fourth factor mad scientists, the fifth factor Working Indoors, the sixth factor experimenting with chemicals, the seventh factor working alone and the eighth factor intelligent.

Data was collected from 385 secondary school students to verify this factor structure of ImSca. From these data, 13 were found to be extreme values and to disrupt the normal distribution and they were removed from the data, confirmatory factor analysis was performed on the remaining 362 data. The model obtained according to the results of the confirmatory factor analysis is shown in Figure 1.

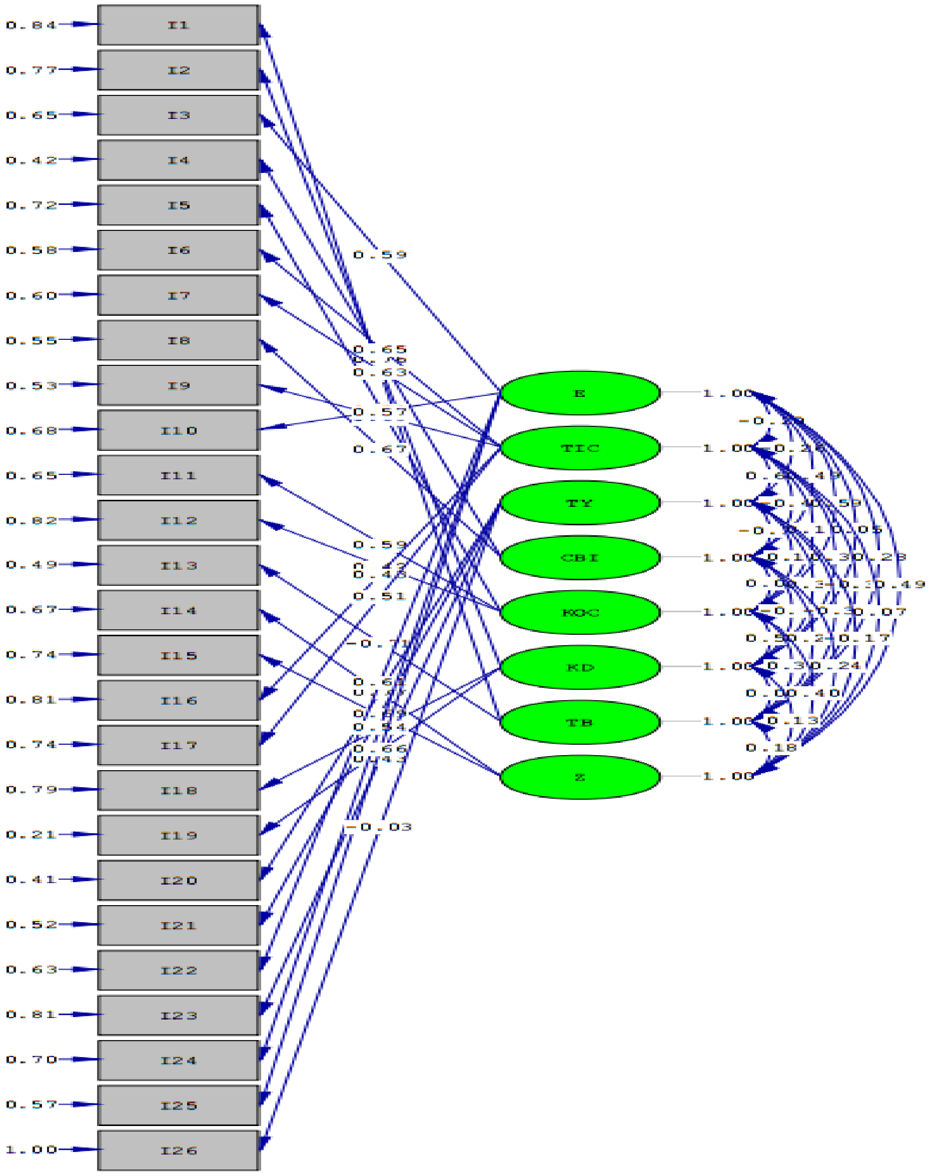

Figure 1. Confirmatory Factor Analysis Model for ImSca

Chi square, degree of freedom and goodness of fit indexes obtained from the confirmatory factor analysis results, are shown in Table 6.

Table 6. Goodness of Fit Indexes for Confirmatory Factor Analysis

Fit Parameter	Coefficient
GFI	.88
CFI	.81
NFI	.71
IFI	.81
RMSEA	.06
Sd	271
χ^2	621.65
χ^2/sd	2.29

Regarding the goodness of fit indices in Table 6, it is seen that GFI coefficient is around .90 and the other coefficients vary between .71 and .81. Considering the obtained RMSEA and χ^2/sd ratio, it can be said that the results of confirmatory factor analysis related to Scientist's Images Scale are at acceptable level, although not at the desired level.

Results regarding the reliability analysis of the scale are presented in Table 7.

Table 7. Internal Consistency Coefficients for the whole ImSca and its Sub-Dimensions

Factors	Number of Items	Alpha
1	5	.69
2	5	.65
3	4	.60
4	2	.70
5	3	.51
6	3	.47
7	2	.34
8	2	.42
Total	26	.69
n=760		

According to Table 7, the reliability coefficients of the sub-dimensions vary between .34 and .70, and the reliability coefficient of the whole scale is .69.

3.2. Findings for the Validity-Reliability of GenSca

The test results performed to check the suitability of the data obtained from the 38-item scale for factor analysis are shown in Table 8.

Table 8. KMO and Bartlett Test Results for GenSca

Kaiser-Meyer-Olkin Sample Sufficiency		.95
Bartlett Sphericity Test	Chi-square Value	11446.19
	Degree of Freedom	253
	P	.00

KMO (.95) and Bartlett sphericity (11446.19, $p < .01$) values obtained from the principal component analysis show that the data distribution of the sample is appropriate for factor analysis (Tavşancıl, 2010). Therefore, it can be said that the data come from a multivariate normal distribution.

In this study, basic components analysis and vertical rotation technique were used for exploratory factor analysis. The eigenvalues of the factors and the scree plot were examined together to determine the number of factors in the scale. According to the results of exploratory factor analysis, the threshold was set as .30 while determining the items to be grouped under a factor. In parallel, the items with factor loads below .30 and the items with a load difference below .10 for at least two factors were not assigned to any factors. In this context, 15 items that do not meet these criteria were excluded from the scale and they were not included in the remaining analyzes. As a result of the analysis repeated by removing these items, the scale items were observed to be grouped under 3 factors with an eigenvalue greater than 1.00. The eigenvalues of the factors and the total explained variance of the scale after the last exploratory factor analysis are given in Table 9.

Table 9. Total amount of explained variance for GenSca

	Factor Eigenvalues		
Factors	Eigenvalues	Explained Variance (%)	Accumulated Explained Variance (%)
1	9.73	28.84	28.84
2	3.19	18.81	47.65
3	1.96	17.08	64.73

Regarding the amount of total explained variance, it is seen that the scale has a three-factor structure and the total variance amount explained by these three factors is 64.73 %. The results of exploratory factor analysis performed to determine the distribution of the items among the factors are shown in Table 10.

Table 10. Rotated Components Matrix after Exploratory Factor Analysis for GenSca

Factors	1	2	3
Items	**Factor Load**	**Factor Load**	**Factor Load**
Item 14	.81	-	-
Item 4	.79	-	-
Item 17	.78	-	-
Item 13	.77	-	-
Item 11	.76		
Item 18	.74	-	-
Item 9	.74	-	-
Item 1	.72	-	-
Item 16	.71	-	-
Item 6	.71	-	-
Item 24	.67	-	-
Item 21	-	.87	-
Item 19	-	.85	-
Item 27	-	.83	-
Item 32	-	.80	-
Item 25	-	.80	-
Item 10	-	.74	-
Item 35	-	-	.78
Item 33	-	-	.76
Item 28	-	-	.76
Item 36	-	-	.74
Item 26	-	-	.71
Item 12	-	-	.61
Eigenvalue	14.28	4.09	2.17
Explained Variance	43.27	12.40	6.58

According to Table 10, the loads of the items grouped under 3 factors vary between .61 and .87. The factors were named as follows, according to the items they contain: the first factor male, the second factor female, and the third factor male or female.

Data was collected from 385 secondary school students to verify this factor structure of GenSca. From these data, 85 were found to be extreme values and to disrupt the normal distribution and they were removed from the data, confirmatory factor analysis was performed on the remaining 300 data. The model obtained according to the results of the confirmatory factor analysis is shown in Figure 2.

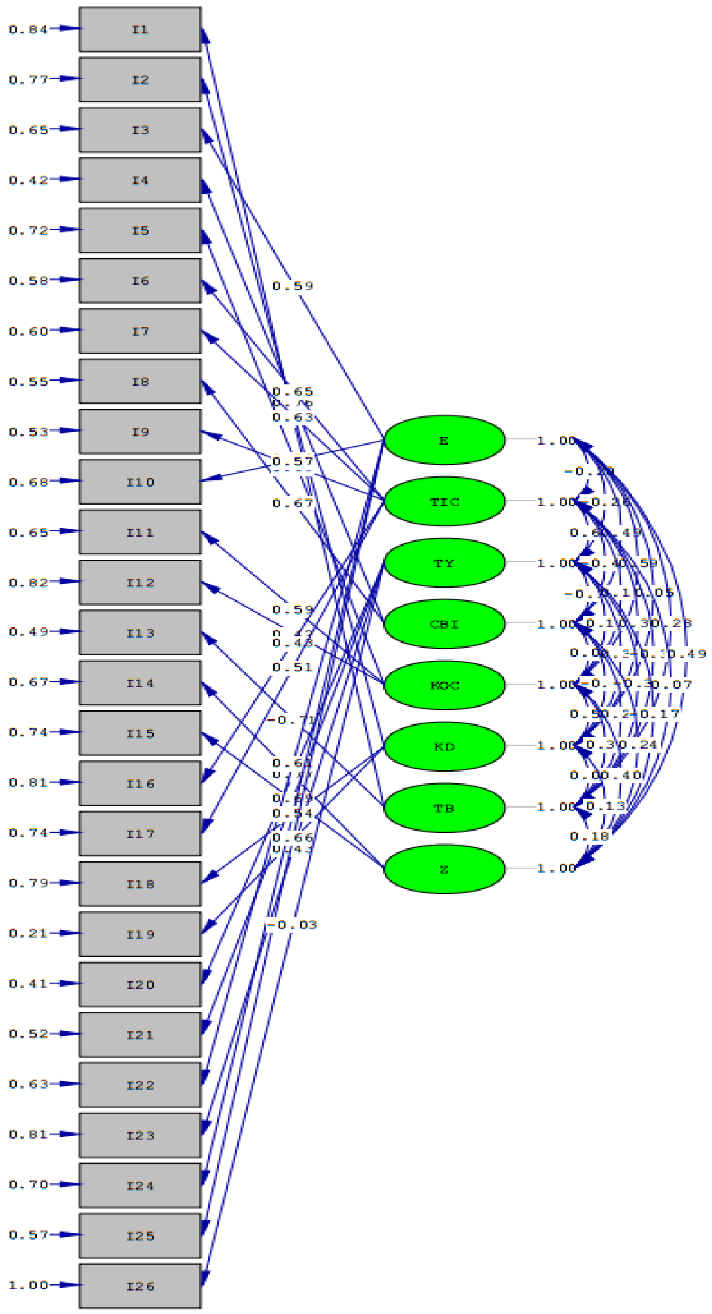

Figure 2. Confirmatory Factor Analysis Model for GenSca

Chi square, degree of freedom and goodness of fit indexes obtained from the confirmatory factor analysis results, are shown in Table 11.

Table 11. Goodness of Fit Indexes for Confirmatory Factor Analysis for GenSca

Fit Parameter	Coefficient

GFI	.86
CFI	.92
NFI	.87
IFI	.92
RMSEA	.07
sd	227
χ^2	553.91
χ^2/sd	2.44

Regarding the goodness of fit indices in Table 11, it is seen that the CFI and IFI coefficients are above .90, and GFI and NFI coefficients are above .85. Considering the obtained RMSEA and χ^2/sd ratio, it can be said that the results of confirmatory factor analysis related to GenSca are at acceptable level.

Results regarding the reliability analysis of the scale are presented in Table 12.

Table 12. Internal Consistency Coefficients for the whole GenSca and its Sub-Dimensions

Factors	Number of Items	Alpha
1	11	.94
2	6	.91
3	6	.86
Total	23	.82
n=760		

According to Table 12, the reliability coefficients of the sub-dimensions vary between .86 and .94, and the reliability coefficient of the whole scale is .82. Considering these coefficients, it can be said that scale items have a consistent structure, therefore the scale is reliable.

3.3. Findings for the Validity-Reliability of RiskSca

First of all, the test results performed to check the suitability of the data obtained from the 56-item scale for factor analysis are shown in Table 13.

Table 13. KMO and Bartlett Test Results for RiskSca

Kaiser-Meyer-Olkin Sample Sufficiency		.94
Bartlett Sphericity Test	Chi-square Value	13599.48
	Degree of Freedom	1540
	p	.00

KMO (.94) and Bartlett sphericity (13599.48, $p < .01$) values obtained from the principal component analysis show that the data distribution of the sample is appropriate for factor analysis (Tavşancıl, 2010). Therefore, it can be said that the data come from a multivariate normal distribution.

In this study, Basic Components Analysis and vertical rotation technique were used for exploratory factor analysis. The eigenvalues of the factors and the scree plot were examined together to determine the number of factors in the scale. According to the results of exploratory factor analysis, the threshold was set as .30 while determining the items to be grouped under a factor. In parallel, the items with factor loads below .30 and the items with a load difference below .10 for at least two factors were not assigned to any factors. In this context, 29 items that do not meet these criteria were excluded from the scale and they were not included in the remaining analyzes. As a result of the analysis repeated by removing these items, the scale items were observed to be grouped under 6 factors with an eigenvalue greater than 1.00. The eigenvalues of the factors and the total explained variance of the scale after the last exploratory factor analysis are given in Table 14.

Table 14. Total amount of explained variance forRiskSca

	Factor Eigenvalues		
Factors	**Eigenvalues**	**Explained Variance (%)**	**Accumulated Explained Variance (%)**
1	7.02	26.02	26.02
2	1.86	6.88	32.90
3	1.45	5.35	38.25
4	1.24	4.58	42.83
5	1.15	4.24	47.07
6	1.02	3.78	50.85
…	…		

Regarding the amount of total explained variance, it is seen that the scale has a six-factor structure and the total variance amount explained by these three factors is 50.85 %. The results of exploratory factor analysis performed to determine the distribution of the items among the factors are shown in Table 15.

Table 15. Rotated Components Matrix after Exploratory Factor Analysis for RiskSca

Factors	**1**	**2**	**3**	**4**	**5**	**6**
Items	**Factor Load**	**Factor Load**	**Factor Load**	**Factor Load**	**Factor Load**	**Factor Load**
Item 44	.69	-	-	-	-	-
Item 52	.60	-	-	-	-	-
Item 46	.59	-	-	-	-	-
Item 18	.59	-	-	-	-	-
Item 5	.50	-	-	-	-	-
Item 21	.34	-	-	-	-	-
Item 24	-	.62	-	-	-	-
Item 14	-	.61	-	-	-	-
Item 32	-	.59	-	-	-	-
Item 12	-	.56	-	-	-	-
Item 49	-	.51	-	-	-	-
Item 53	-	.51	-	-	-	-
Item 10	-	-	.73	-	-	-
Item 11	-	-	.67	-	-	-
Item 17	-	-	.65	-	-	-
Table 15 is continued						
Item 16	-	-	.60	-	-	-
Item 48	-	-	.40	-	-	-

Item 31	-	-	.40	-	-	-
Item 8	-	-	-	.75	-	-
Item 9	-	-	-	.74	-	-
Item 15	-	-	-	.50	-	-
Item 35	-	-	-	-	.71	-
Item 26	-	-	-	-	.68	-
Item 54	-	-	-	-	.45	-
Item 3	-	-	-	-	-	.68
Item 4	-	-	-	-	-	.67
Item 2	-	-	-	-	-	.62
Eigenvalue	7.02	1.86	1.45	1.24	1.15	1.02
Explained Variance	26.02	6.88	5.35	4.58	4.24	3.78

According to Table 15, the loads of the items grouped under 6 factors vary between .34 and .75. The factors were named as follows, according to the items they contain: the first factor risk of being punished by the society, the second factor risk of losing health, the third factor risk of injury/death, the fourth factor risk of an asocial Life, the fifth factor risk of wasted labor, and the sixth factor psychological risks.

Data was collected from 385 secondary school students to verify this factor structure of RiskSca. From these data, 7 were found to be extreme values and to disrupt the normal distribution and they were removed from the data, confirmatory factor analysis was performed on the remaining 378 data. The model obtained according to the results of the confirmatory factor analysis is shown in Figure 3.

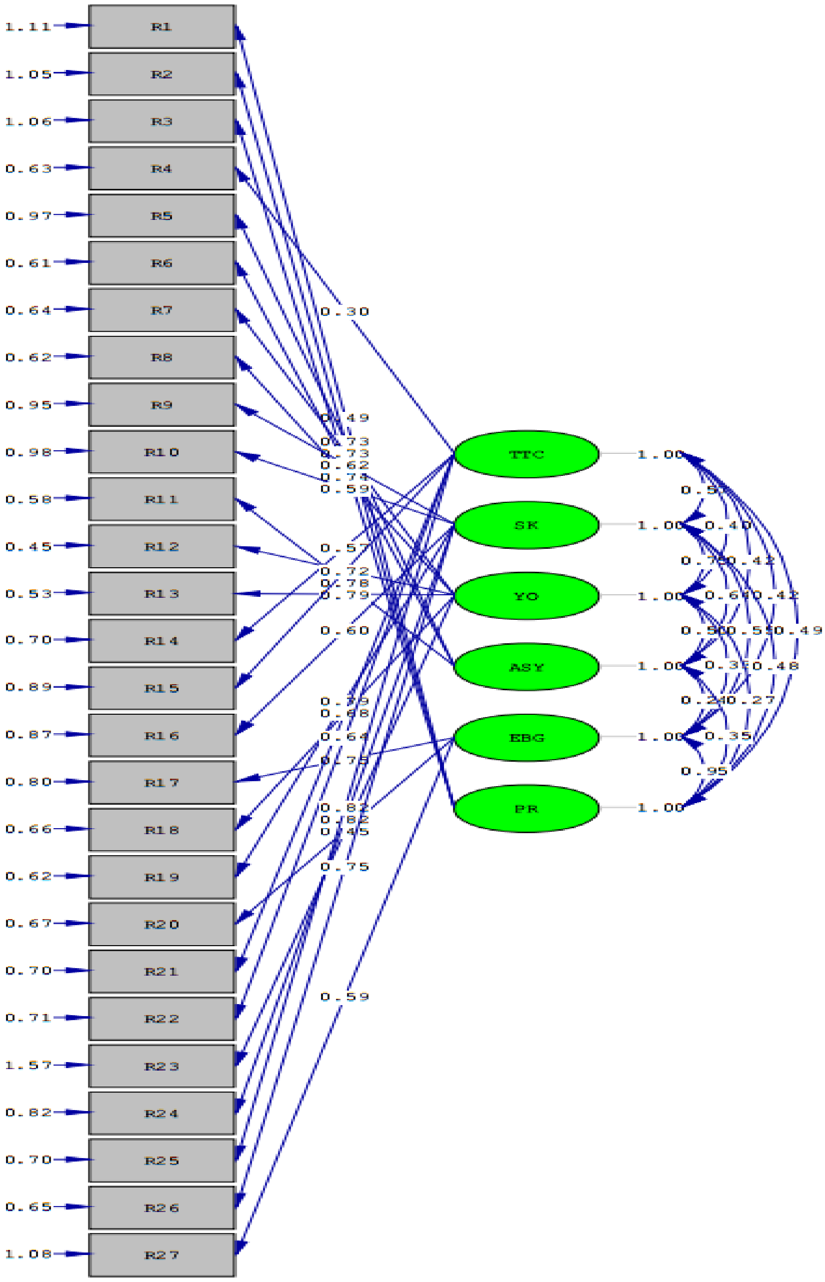

Figure 3. Confirmatory Factor Analysis Model for RiskSca

Chi square, degree of freedom and goodness of fit indexes obtained from the confirmatory factor analysis results, are shown in Table 16.

Table 16. Goodness of Fit Indexes for Confirmatory Factor Analysis for RiskSca

Fit Parameter	Coefficient
GFI	.88
CFI	.89
NFI	.80
IFI	.89
RMSEA	.05
Table 16 is continued	
sd	309

χ^2	662.29
χ^2/sd	2.14

Regarding the goodness of fit indices in Table 16, it is seen that the coefficients are above .80 and close to .90. Considering the obtained RMSEA and χ^2/sd ratio, it can be said that the results of confirmatory factor analysis related to RiskSca are at acceptable level.

Results regarding the reliability analysis of the scale are presented in Table 17.

Table 17. Internal Consistency Coefficients for the whole Scale and its Sub-Dimensions

Factors	Number of Items	Alpha
1	6	.73
2	6	.74
3	6	.72
4	3	.70
5	3	.49
6	3	.52
Total	27	.88
n=760		

According to Table 17, the reliability coefficients of the sub-dimensions vary between .49 and .74, and the reliability coefficient of the whole scale is .88. Considering these coefficients, it can be said that scale items have a consistent structure, therefore the scale is reliable.

3.4. Findings for the Determination of the Relationships among the Sub-Scales

The results of the correlation analysis for determining the relationships between the sub-scales of the scales developed within the scope of the research and whose factor structures are confirmed are shown in Table 18. Accordingly, the following medium-level, positive relationships were discovered among the perceptions: Between Masculine Scientist and Mad Scientist (r = .38, p <.05), Scientist working in Indoor Environment (r = .49, p <.05), Male Scientist (r = .38) , p <.05), Risk of Losing Health (r = .37, p <.05), Risk of an Asocial Life (r = .40, p <.05); Between Scientist Working for Society and Mad Scientist (r = .41, p <.05); Between Scientist Working in Indoor Environment and Scientist who Performs Chemical Experiments (r = .31, p <.05), Risk of Losing Health (r = .39, p <.05), Risk of an Asocial Life (r = .30, p <.05); Between Scientist Working Alone and Risk of an Asocial Life (r = .39, p <.05); Between Intelligent Scientist and Risk of Losing Health (r = .30, p <.05); Between Male Scientist and Female Scientist (r = .55, p <.05), Risk of an Asocial Life (r = .30, p <.05); Between Female Scientist and Risk of an Asocial Life (r = .31, p <.05); Between Risk of Punishment by the Community and Risk of Losing Health (r = .43, p <.05), Risk of Injury/ Death (r = .31, p <.05), Risk of Wasted Labor (r =. 41, p <.05), Psychological Risk (r = .36, p <.05); Between Risk of Losing Health and Risk of Injury/Death (r = .64, p <.05), Risk of an Asocial Life (r = .48, p <.05), Risk of Wasted Labor (r =. 45, p & p< .05); Between Risk of Injury/Death and Risk of an Asocial Life (r = .30, p <.05), Risk of Wasted Labor (r = .35, p <.05); Between Risk of Wasted Labor and Psychological Risk (r = .52, p <.05). A moderate negative correlation is observed between the perception of Male Scientist and Scientists of Both Genders (r = -. 35, p <.05). Other correlations between variables were found to be low level or statistically insignificant. All correlations of Risks of Being a Scientist and the Perception of the Scientist's Gender subscales were statistically significant, whereas some correlations between the Scientist in Images Subscales are insignificant. It is remarkable that the perception of being a Scientist of Both Genders subscale does not have any significant correlation with the subscales of other scales.

Table 18. Pearson Product-Moments Correlation Matrix between the subscales of ImSca, GenSca, and RiskSca

Variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
1–Masculine	1	-.12*	.00	.38*	.49*	.17*	.25*	.26*	.38*	.26*	-.09	.19*	.37*	.22*	.40*	.27*	.15*
2–Working for the Society		1	.41*	-.26*	.01	.15**	-.20*	.06	-.03	-.03	.11	-.15*	-.11	-.03	-.14*	.06	.03
3– Meticulous /Creative			1	-.13*	.21*	.19*	-.06	.14*	-.03	.09	.11	.04	.17*	.10	.10	.16*	.19*
4 - Mad Scientist				1	.15*	.14*	.21*	.09	.14*	.05	-.09	.16*	.20*	.16*	.12*	.08	.01
5– Working Indoors					1	.31*	.22*	.28*	.17*	.21*	.04	.11	.39*	.29*	.30*	.18*	.15*
6– Experimenting with Chemicals						1	.13*	.10	.11	.19*	.08	.10	.20*	.24*	.10	.19*	.07
7– Working Alone							1	.15*	.07	.21*	-.04	.10	.27*	.24*	.39*	.20*	.11
8– Intelligent								1	.19*	.20*	.05	.16*	.30*	.15*	.26*	.13*	.17*
9– Male Scientist									1	.55*	-.35*	.26*	.19*	.13*	.30*	.11	.12*
10– Female Scientist										1	-.16*	.23*	.29*	.19*	.31*	.14*	.16*
11– Male or Female Scientist											1	-.07	.01	.02	-.09	.01	.09
12– Being Punished by the Society												1	.43*	.31*	.29*	.41*	.36*
13– Losing Health													1	.64*	.48*	.45*	.28*
14– Injury/Death														1	.30*	.35*	.19*
15– An Asocial Life															1	.23*	.20*
16– Wasted Labor																1	.52*
17– Psychological																	1

n =295, *p<.05, ** p<.01

4. Conclusion, Discussion and Suggestions

In this study, three different scales have been developed to determine high school students' scientist image, perceptions of the gender of scientist and the risks they have. ImSca consisting of eight sub-factors and 26 items, namely masculine, working for the society, meticulous/creative, mad scientist, working indoors, experimenting with chemicals, working alone and intelligent, was developed to determine high school students' image of scientist. In order to determine high school students' perceptions of the gender of the scientist, GenSca consisting of three sub-factors (male, female and male or female) and 33 items was developed. Finally, another scale that is RiskSca was developed to determine high school students' perceptions of the risks that the scientist has. This scale consists of six sub-factors and 27 items, namely the risk of being punished by the society, the risk of losing health, the risk of injury/ death, the risk of an asocial life, the risk of wasted labor and psychological risks. As a result of the analysis of the data obtained in this study, it was found that the psychometric properties of these three scales are sufficient.

ImSca measures the stereotyping of the scientist image of individuals. The higher score that an individual gets from the scale means the more stereotypical scientist image. The first dimension is aimed at determining how individuals perceive the gender and characteristics of the scientist. This dimension contains five items. Some of the items of this dimension are; *the scientist is a man, has a beard, and his hair is messy*. The maximum score that individuals can get from this dimension is 25. The second dimension is the scientist working for the society, which also consists of five items. Some of the items of this dimension are; *the scientist is kind, comes to weak people's aid, and informs people*. The maximum score that individuals can get from this dimension is also 25. The third dimension, consisting of four items, is the meticulous/creative dimension. Some of the items of this dimension are; w*orks in a planned way, is tidy and meticulous, thinks creatively.* The maximum score that individuals can get from this dimension is 20. The fourth dimension of the scale, which consists of two items, is the mad scientist. This dimension includes *scientist has evil purposes such as taking over the world, developing monsters or weapons to take over the world.* The maximum score that individuals can get from this dimension is 10. The fifth dimension, which is called working indoor, contains three items, which are *the scientistworking indoor such as a laboratory or study room, works in quiet and deserted environments, the working environment is full of books*. The maximum score that individuals can get from this dimension is 15. Similarly, the sixth dimension is experimenting with chemical. The items of this dimension are as follows: "*The scientist makes experiments with chemicals, conducts dangerous experiments, works on chemical formulas*". The maximum score that individuals can get from this dimension is 15. The seventh dimension, which is named as working alone, consists of two items, which are *the scientist works alone, has many friends to spend time and work together.* The second item should be scored in the reverse order as it is negative to the working alone dimension. The maximum score that individuals can get from this dimension is 10. The eighth and final dimension of the scale, which consists of two items such as the seventh dimension, is named as intelligent. This dimension includes *the scientist is smarter than other people, knows everything you can think of*". The maximum score that individuals can get from this dimension is also 10. The alpha values of the dimensions of the scale vary between .34 and .70. As a result of the confirmatory factor analyzes, the goodness of fit indices are at an acceptable level, indicating that the scale structure is confirmed.

GenSca determines individuals' perceptions of the scientist's gender. The first of the three dimensions of the scale determines the perceptions about the male scientist. This dimension consists of 11 items. Some of the items in this dimension are: "*The scientist must be a man because women cannot afford to work with heavy machinery; the scientist is a man because men are more hard-working*." The maximum score that individuals can get from this dimension is 55. The second dimension includes six items for determining the perceptions of female scientist. Some of the items in this dimension are: "*The scientist is a woman because women do what they set on their mind; the scientist is a woman because women care more about what they do compare to men*". The maximum score that individuals can get from this dimension is 30. There are six items in the last dimension of the scale, male or female. Some of these items are: "*Anyone who thinks to have talent can choose scientist as profession, regardless of the gender. Since there are both male and female scientists who have been successful in history, there can be scientists of both sexes*". The maximum score that individuals can get from this dimension is also 30. Although the dimensions of the scale don't contain any negative items, to determine the male scientist perception in the scale, the items belonging to "women" and "men or women" dimensions should be scored in reverse order.

In this way, the high score achieved from the scale means that they perceive the scientist as male and low score means that they perceive as female. This scoring approach can be used in studies based on the survey model. However, if pretest-posttest model is used in the study, the changes in each sub-dimension should be evaluated separately. The high alpha values (Male = .94, Female = .91, Male or Female = .86) related to the sub-dimensions of the scale indicate that the items in the sub-dimensions are consistent with each other. Confirmatory factor analyzes of the scale also show that the factor structure is confirmed.

RiskSca, which is the last scale developed in the study, measures individuals' perceptions of the risks that the scientist has. The higher score that an individual gets from the scale means that they perceive scientist as a riskier profession. The first dimension of the scale is the risk of being punished by the society. The items of this dimension are intended to identify individuals' perceptions of the scientist's risk of being punished by society. This dimension consists of six items. Some of the items in this dimension are; *"If a scientist cannot find solutions to society's problems, he/she is blamed by those around him/her, if the invention of the scientist does not work; he/she is despised by people"*. The maximum score that individuals can get from this dimension is 30. Likewise, the second sub-dimension consisting of six items is the risk of losing health. This dimension contains items to determine whether individuals have a perception of a risk of losing health for the scientist. Some of the items in this sub-dimension are; *"Since the scientist sits at the computer for a long time, his waist and/or neck hurts, the scientist gets sick because he/she works day and night and is unable to rest."* The maximum score that individuals can get from this dimension is 30. Another dimension in the scale is the risk of injury/death. This dimension contains items related to determining the perceptions of whether the scientist is at risk of injury or death. Some of the items in this dimension consisted of six items are; "*When the scientist works with a poisonous animal, the poisonous animal will kill him/her, the scientist who spills chemicals such as acid will burn."* As the other dimensions, the maximum score that individuals can get from this dimension is 30. The fourth dimension, consisting of three items, is the risk of an asocial life. This dimension determines whether individuals have a perception of asocial life for the scientist. Some of the items in this sub-dimension are; "*Since the scientist spends most of his life at work, he/she has no social life, since the scientist works hard, he/she cannot spare time for his/her family.*" The maximum score that individuals can get from this dimension is 15. Similarly, another dimension of the scale, which contains three items, is the risk of wasted labor. The items of this dimension intend to determine whether individuals perceive that the scientist's labor is at risk of wasting. Some of the items are; *"The scientist gets upset if he/she does not reach the desired result even though he/she has worked hard, the scientist gets upset if nobody is interested in his/her discovery."* The maximum score that individuals can get from this dimension is 15. The last dimension of the scale, which consists of three items, is psychological risks. This dimension is aimed at determining the perception of the psychological risks that the scientist has. Some of the items in this sub-dimension are; "*If a person dies of the medicine made by the scientist, he/she feels a twinge of guilt, when the scientist makes an invention, he/she gets disappointed if he/she finds out that someone else did it as well*." The maximum score that individuals can get from this dimension is also 15. Individuals' perceptions of the risks of the scientists can be determined from the total score to be obtained from the scale, as well as comments can be made regarding the sub-dimensions. The scale does not contain any negative items. For this reason, reverse order scoring is not needed. Regarding the alpha values of the dimensions, they are high; therefore the items in the sub-dimension are consistent. Also, confirmatory factor analysis results show that the scale structure has been confirmed. In this regard, it can be thought that the scale can be used in studies aimed at determining the perceptions of scientists' risk.

Encouraging individuals to pursue a career in the fields of science have been one of the general objectives of all science and technology curricula that have been revised and implemented since 2006in our country. The major factor against the realization of these objectives of the curricula is the scientist image that individuals have and the perception of scientist's gender and the risks he/she has, which are shaped accordingly. In this regard, it is essential to conduct studies to change the scientist's images and perceptions that students have. In this respect, it is thought that the scales developed in the study will direct the mentioned researches.

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