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SECONDARY SCHOOL STUDENTS' PERCEPTIONS AND ATTITUDES ABOUT SCIENTISTS

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Abstract:
This research was carried out to determine secondary school students' perceptions and attitudes towards scientists. The study group consists of 53 fifth and sixth grade students receiving education in a state secondary school in Turkey. Convergent parallel design among mixed research methods was used during the research. Research data were collected using "Questionnaire on attitudes towards scientists" and "Draw A Scientist (DAS)" forms. Descriptive and inferential statistical methods and content analysis were used for analysis of the obtained data. Research findings indicate that, female students and sixth grade students exhibited higher attitude levels towards scientists as compared to male and fifth grade students, respectively. This difference between the attitude levels, however, was not found to be significant. Although female students drew male figures to depict scientists, they were more eager to become scientists as compared to male students. The results obtained from the drawings indicated that students generally perceive scientists as hardworking and smart male individuals wearing gown, glasses or protective glasses, tie or bowtie, mustache with a peculiar hairstyle or with no hair. Majority of students defined the activities of scientists as inventing, discovering, making space research or scientific projects. The results obtained from the inventory showed that, the majority of students depicted scientists as creative, problem-solving individuals that discover new information and design new stuff. Research results also showed that students have stereotyped opinions about scientists and they generally confuse the working fields of scientists with those of engineers.

Keywords: fifth and sixth grade students, science, scientist, perception, attitude, stereotyped perceptions

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1. Introduction

In the twenty first century, raising generations with international competitiveness have become a necessity for countries. The skills that should be owned by the individuals of this generation are known as twenty first century skills. These skills are generally stated as critical thinking, entrepreneurship, communication, cooperation, decision making, leadership, curiosity and imagination, learning to learn, problem-solving, responsibility and creativity (P21, 2015). Countries have been in search of new educational models to raise individuals with such skills. As a result of these efforts, the curriculum of science course in Turkey was updated in 2017 so as to include science and engineering applications and engineering design skills (MoNe, 2017). The focus of this update was Science, Technology, Engineering and Math (STEM) education. This abbreviation (STEM) was initially used in 2001 by Judith A. Ramaley from National Science Institution, and it introduces an integrated approach for the fields of science, technology, engineering and math (Watson & Watson, 2013).

Participation of students in STEM education increases their interest in STEM fields and professions at earlier ages (Maltese & Tai, 2010). Students' perception and attitudes towards scientists, as a STEM profession, have a significant influence on their attitudes towards science and their career preferences in the future. (Finson, 2002, Finson, Riggs & Jesunathadas, 1999; Schibeci, 1986). Negative stereotyped opinions and attitudes of students towards scientists also have negative impacts on their perception of science (Schibeci & Sorensen, 1983). Literature findings show that, female students prefer science fields in their careers at very low rates as a result of their negative perceptions of science (Ross, 1993).

Students' perceptions of science and scientists were initially studied by Mead and Meatrux (1957) in high schools of the USA. The findings of this research revealed that the majority of students defined scientists as middle-aged, tired, male individuals with messy hair and hunchback that wear a white gown, mustache and glasses, work in laboratories, surrounded with test tubes, Bunsen burners, flasks and such equipment. In later years, Chambers (1983) developed the "Draw A Scientist Test (DAST)". Chambers applied this test on 4800 fifth grade students in United States, Australia and Canada. Research findings showed that, students depicted scientists as male individuals with a beard or mustache that wear a gown and use technological devices, research and information symbols.

Related literature involve numerous studies in which the perceptions of primary and secondary school students about scientists are determined using DAST (Barman, 1999; Barman, Ostlund, Gatto & Halferty, 1997; Buldu, 2006; Fung, 2002; Kaya, Doğan & Öcal, 2008; Kemaneci, 2012; Kibar Kavak, 2008; Losh, Wilke & Pop, 2008; Narayan, Park, Peker & Suh, 2013; Newton & Newton, 1992; Newton & Newton, 1998; Song & Kim, 1999; Yontar Toğrol, 2013). Findings of several studies revealed that the stereotyped opinions of students regarding scientists generally develop as from kindergarten and primary school years (Losh et al., 2008; Newton & Newton, 1992; Newton & Newton, 1998).

In a study on determination of primary students' perceptions of scientists, students were asked to draw teachers and veterinaries in addition to scientists. Students were found to depict scientists as less attractive and cheery individuals than teachers, moreover, they were found to depict scientists as male and teachers as female individuals. (Losh et al., 2008). Newton and Newton (1998) applied DAST on 1000 children at 4-11 age group in England, and reported that, scientists were mostly defined as male figures that work in indoor environments such as laboratory, working room etc., and wear a laboratory gown.

A study on Korean students' perceptions of scientists involved 1137 participating students at the ages of 11, 13 and 15. Research data was collected with DAST and a questionnaire form. Research results showed that 60.40% of female students and 89.70% of male students imagined scientists as male individuals. Accordingly, in spite of the higher rate of female individuals in scientist-depictions of female students, male scientists were depicted at higher rates in overall results. Students depicted scientists while they were making a research (33.60%), an experiment (28.60%), invention (13.60%), observation (1.80%), and giving a lecture (1.60%) (Song & Kim, 1999).

Fung (2002) applied DAST on 675 students from three primary and three secondary schools in Hong Kong to determine their perceptions of scientists. 62.80% and 10.60% of the students at 11-12 age group drew male and female scientists, respectively, whereas 62.50% and 10.00% of the participants in 13-14 age group drew male and female scientists, respectively. All drawings involved illustrations of laboratory equipment and flasks, and the majority of drawings involved male scientist illustrations.

A related study performed with 1800 third, seventh and eighth grade students receiving education in China, India, South Korea, Turkey and USA showed that, the majority of students imagined scientists as male individuals working in a laboratory and wearing a gown. No correlation was found between the students' perceptions of a scientist and their career preferences. However the willingness of students, with the perception of science as an active action, to become a scientist was found to be higher than those that regarded science as a passive action (Narayan et al., 2013).

Lyons, et al. investigated the perceptions and attitudes of 357 secondary school students towards scientists using their inventory. Research findings showed that, students imagined scientists as individuals discovering new information, finding the best way to solve a problem, performing multiple tasks, using different ways of communication, earning a lot of money and using their mind in their workplaces. The majority of female students depicted scientists as individuals that earn a lot of money, work individually, do their job with their hands and that are most likely to become a boss. Also, 91.00% of students stated that they loved or enjoyed science (Lyons, Fralick & Kearn, 2009).

A study carried out with 30 students of 5-8 age group in Turkey revealed that, illustrations of students about scientists were mostly based on gender, age and social status. Research results showed that, students with low socioeconomic status used more stereotyped figures in their drawings. As opposed to the findings of Chambers (1983),

in this research, streotyped perceptions of scientists were encountered at lower rates as in the drawings of senior students, and these drawings included more details. Also, none of the male students depicted a female scientist, whereas illustrations of female scientists were encountered in the drawings of female students (Buldu, 2006).

In another study, the attitudes and perceptions of 623 4th, 5th, 6th, 7th and 8th grade students were determined using DAST and semi-structured questions. Research results showed that, female students preferred to draw scientists as female individuals and male students chose to draw scientists as male individuals. In overall drawings, depictions of male scientists prevailed. Students were found to imagine scientists as smart people who looked like no one in their own environment, with stereotyped judgments which were also encountered in their previous research findings. Moreover, students' attitudes towards science were found to not vary on the basis of gender, but on the basis of grade levels, the highest attitude belonging to sixth, and the lowest belonging to eighth grade students (Kibar Kavak, 2008).

DAST and and a likert-scale was used in a study on determination of perceptions and attitudes of gifted children towards scientists. Research results indicated that, students generally imagined scientists as individuals wearing gown and glasses, and making experiments. These students had positive opinions as to the potential of females to become scientists, although they mostly drew male individuals to illustrate a scientist. Additionally, the opinions of students about scientists were found to vary based on their gender and grade level (Kemaneci, 2012).

In a study carried out to determine the attitudes of 304 Turkish secondary school students towards scientists using DAST, students illustrated scientists as bald (19.70%) and bearded (11.50%) individuals wearing a gown (41.80%) and glasses (30.90%). Also, 78.00% of the students drew scientists as male individuals (Kaya et al., 2008). Another study which was carried out to determine the perceptions of 10-13 year old Turkish students about scientist using DAST, involved a total of 520 students. 1.54% of the students drew scientists as individuals working with a team, whereas 68.00% of the students drew scientists as "male" individuals. Although 53.00% of the participants consisted of female students, only 13.00% of them drew female scientists (Yontar Toğrol, 2013).

Özdeş (2014) investigated 5th, 6th, 7th and 8th grade students' perceptions of scientists with a view to determine whether these perceptions are effective on their career preferences in the future, using DAST, open-ended questions and semi-structured interviews. Research findings revealed that, at least 60% of both female and male students wanted to become a scientist in the future, although the majority of them illustrated scientists as male individuals. Moreover, students that did not have a desire to become a scientist were encountered among female students who drew female, or female and male scientists.

In another research, the perceptions of 184 students from 4th, 5th and 6th grades about scientists were determined using DAST and "Scientist Evaluation Questionnaire". In the research, 70.10% of the participating students stated that they would like to become a scientist in the future. The students mostly defined scientists as

smart and gentle people that loved to make research generally in the fields of physics and chemistry by use of computers, microscopes, telescopes, robots and space equipment (Nuhoğlu & Afacan, 2011).

The findings of all abovementioned studies on determination of primary and secondary school students' perceptions of scientists show that, students in general have stereotyped perceptions of scientists. Such perceptions generally involve bearded and middle aged individuals with messy hair, wearing glasses and a gown, working alone in a laboratory with laboratory equipment. Since DAST only require students to make drawings, some limitations may be encountered during the application and analysis of this data collection tool (Öcal, 2007). Such limitations may be encountered both in application and in analyses stages. For instance, students with high drawing skills are more likely to illustrate what they imagine; whereas those with lower drawing skills may not be qualified for determination of perceptions. Also, the data-analysis stage should involve at least one professional from the fields such as psychology, sociology, pediatric development, visual arts and science teaching to interpret drawings. As a data-collection tool, DAST is not qualified for reflection of the abstract attributes of scientists, accordingly drawings of students obtained with this test cannot go beyond a physical point of view. In this regard, DAST should be supported by interviews or likert-type scales as a means for reaching the abstract attributes of scientists (Song & Kim, 1999).

1.1. The Aim of Research

In this study, determination of the perceptions and attitudes of fifth and sixth grade students towards scientists was aimed. This study holds importance for determination and comparison of perceptions and attitudes of fifth and sixth grade students towards scientists in their first years of secondary school. In addition to DAST, a likert-type scale adapted into Turkish is also used by the researchers. The problem statement of the research was specified as "*what is the extent of fifth and sixth grade students' perceptions of and attitudes towards scientist"*. Sub-problems of the research are as follows:

1. To what extent do the students in general wish to become a scientist?
2. Does the students' eagerness to become a scientist vary on the basis of their gender?
3. Does the students' eagerness to become a scientist vary on the basis of their grade level?
4. Do the students' attitudes towards scientists vary on the basis of their gender?
5. Do the students' attitudes towards scientists vary on the basis of their grade level?
6. What is the general level of student attitudes towards scientists?
7. How do students perceive a scientist's gender?
8. Do the students' perceptions of a scientist's gender vary on the basis of their own gender?
9. What is the general perception of students regarding scientists?

2. Methodology

Mixed methods research design, in which a combination of qualitative and quantitative research methods are used, was applied in the present research. Creswell and Plano Clark (2007) defined this method as a technique which provides a better understanding of the research problem by combined use of qualitative and quantitative methods, instead of a single method.

2.1. Research Design

Convergent parallel design was used in the present study for which mixed methods design was adopted. Convergent parallel design aims to collect a wide variety of data that complement each other as a means for defining the problem in the best possible way (Morse, 1991). This design results from simultaneous application of qualitative and quantitative stages during the course of the research. Researcher attaches even priority to the methods and discriminates these stages during analysis, afterwards recombines the results during general interpretation (Creswell & Plano Clark, 2015). The quantitative data of this research were obtained by means of a likert type scale and qualitative data were obtained using the drawing in the DAST form and open-ended questions.

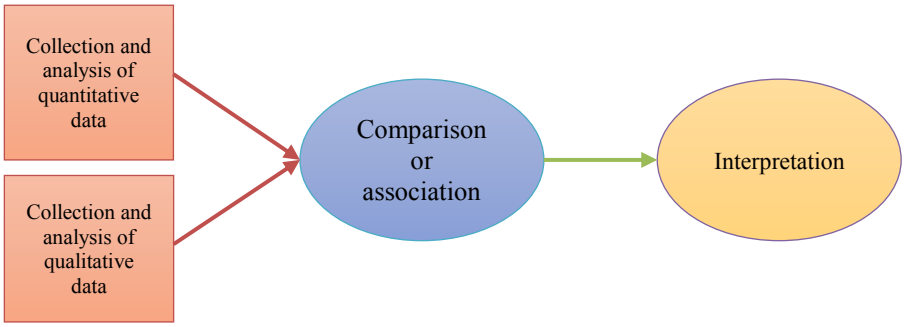


Figure 1: Schematized illustration of convergent parallel design stages (Creswell & Clark, 2015, p.77)

2.2. Study Group

The study group of this research consists of 53 students receiving education in a state secondary school in Bitlis Province Adilcevaz district as of 2016-2017 educational period. Gender and grade-based distribution of the study group is given in Table 1.

Table 1: Gender and grade-based distribution of the study group

Grade level	**Gender**		**Total**
	Male	Female	
5	12	8	20
6	15	18	33
Total	27	26	53

2.3. Data Collection Tools

2.3.1. Questionnaire on Attitudes towards Scientists

The "questionnaire on attitudes towards engineers and scientists", developed by Lyons, Fralick and Kearn (2009) and adapted into Turkish by Ergün and Balçın (2017), was used during the research. The adapted version of the scale in likert-5 type contains 22 items and 2 factors. The first 11 items of 22 items is also referred to as the first factor which involves the items related to attitudes towards scientists, and the remaining 11 items are referred to as the second factor which is related to the attitudes towards engineers. The first 11 items corresponding to factor 1 and consisting of the statements as to scientists are used in the present study. Cronbach Alpha reliability coefficient of these 11 items is .88. The questionnaire involves the question "*do you want to be a scientist in the future"* to determine whether the students have a desire to become a scientist. The "Questionnaire on Attitudes towards Scientists" is given in Annex 1.

2.3.2. Worksheet (DAS form)

The worksheet used in the research is the "Draw-A-Scientist" (DAS) form used by Fralick, Kearn, Thompson and Lyons (2009). The front side of the form involves a large framed area for students to draw their illustration of a scientist, and underneath, there is a space to write the name of the scientist. The back side of the form involves the questions "*What are the personal characteristics of a scientist?", "How is the working environment of a scientist?","What type of works does a scientist do?", and "What is the scientist that you have drawn is doing?"* The construct validity of the open-ended questions was evaluated and verified by two professionals from the field of science teaching and a linguist. The worksheet used in the research is given in Annex 2.

2.4. Application Period

In the application period, the researcher used two measurement tools independently from each other. The participants were given forty five minutes to make the drawing on the front side of the form and reply the questions on the back side of the form. Additionally, they were recommended to use colored pencils during the drawing stage. They had twenty five minutes to respond the items in the *Questionnaire on Attitudes Towards Scientists.*

2.5. Data Analysis

SPSS (Statistical Package for the Social Sciences) 18.0 software package was used for the analysis of the quantitative data obtained from the questionnaire. The questionnaire involved 11 positive attitude items and no negative attitude items. The responses to the questionnaire items were as follows: "absolutely agree" (5) points, "agree" (4) points, "indecisive" (3) points, "disagree" (2) points, and "absolutely disagree" (1) points. The highest possible score was specified as 55 and the lowest possible score was specified as 11. Scores between 40.34 – 55 were indicative of a good attitude towards scientists,

scores between 25.67 – 40.33 were indicative of a moderate attitude towards scientists, and scores between 11-25.66 were indicative of a low attitude towards scientists.

Firstly, it was determined whether the scores received by students from the questionnaire exhibited a normal distribution. The normal distribution characteristic of the scores received from a continuous variable can be evaluated using descriptive statistics such as coefficient of skewness, arithmetic mean, median and mode, and through graphical and normality tests (Büyüköztürk, Kılıç-Çakmak, Akgün, Karadeniz & Demirel, 2016). In this research, Kolmogorov, Smirnov normality test was used since the study group was larger than 50 participants. The results of Kolmogorov-Smirnov test related to the overall attitude scores of the students are given in Table 2; the findings on the skewness and kurtosis coefficients of the scores are presented in Table 3.

Table 2: Normality test results of the total scores received from the questionnaire

	Kolmogorov-Smirnov		
	Statistics	**sd**	**p**
Total attitude score	.217	53	.000

Table 3: Arithmetic mean, median, standard deviation, coefficients of skewness and kurtosis results related to the total scores received from the questionnaire

Total attitude score				
$\bar{X}$	μ_e	**S**	**Coeff. of skewness**	**Coeff. of Kurtosis**
42.34	45.00	9.90	-1.612	2.118

According to Büyüköztürk (2015), an analysis result is built in the form of statistical (null) hypothesis (distribution of the scores cannot significantly differ from the normal distribution), thus, calculated p values higher than $\alpha = .05$ indicate that the scores does not significantly deviate from normal distribution in this significance level. Huck (2008) reported that, in normal distribution, skewness values should be within +1 – -1 range, and, kurtosis values should be within +2 – -1 range. (cited in Seçer, 2015). As shown in Table 2, p is lower than .05; and as indicated in Table 3, skewness is out of +1 – -1 range, and kurtosis is out of +2 – -1 range. It can be inferred in light of these data that, the participating students' total attitude scores did not exhibit a normal distribution. Mann Whitney U-test was used for the pairwise groups since total attitude scores, obtained from the questionnaire on attitudes toward scientists, did not exhibit normal distribution.

2.6. Analysis of Data Obtained from the Worksheet (DAS form)

During the analysis of data obtained from DAS forms, the students were coded as S1, S2, …. Content analysis was used in evaluation of the students' drawings and their responses to the open-ended questions. In content analysis, the research data that show similarities within themselves are gathered within the frame of specific concepts and themes, afterwards they are reorganized and interpreted in a way that readers can follow (Yıldırım & Şimşek, 2013). The data obtained from the responses of students to the open-ended questions in the worksheet were transferred into digital environment

via a computer, and a 53-pages document was created. The findings obtained from the opinions in this document were evaluated and the coded. Afterwards the codes were categorized to build the themes. The processes of coding and categorization of the codes were separately conducted by two researchers. In the next stage, two researchers collaborated to review the themes and remove discrepancies. The frequencies and percentages of code statements by students were calculated accordingly. Since the response of a single student could be covered by multiple themes, total frequency was found to be higher than the size of the study group. Statement percentage was found by dividing the number of statements for a specific theme by total number of statements.

The reliability of data was calculated by the formula ([Consensus / (Consensus + Dissensus)] x 100) developed by Miles and Huberman (1994). In this research, the percentages of agreement for codings were found using this formula as; 0.89 for the first question, 0.88 for the second question, 0.92 for the third question, 0.93 for the fourth question; and the general percentage of agreement for all questions was found as 0.91. According to Yıldırım and Şimşek (2013), the reliability percentage is achieved when the percentage of agreement in the reliability calculation reaches 70%. Accordingly, the obtained values are indicative of an adequate reliability for the codings performed by the researchers.

3. Findings

3.1. Findings Related to the First Sub-Problem

The question "*Do you want to be a scientist in the future"* was included in the questionnaire to determine whether the students desired to become a scientist. The frequency and percentage values as to the desires of students to become a scientist were found on the basis of the responses to this question, and these are presented in Table 4.

Table 4: Findings as to the desire to be a scientist

Desire to be a scientist	**N**	**%**
Yes	26	49.1
No	26	49.1
I am not sure	1	1.9
Total	53	100

As indicated in Table 4, 49.10% (f=26) of the students stated that they wanted to be a scientist, 49.10% (f=26) stated that they did not want to be a scientist and 1.90% (f=1) stated that they were not sure as to whether they wanted to be a scientist.

3.2. Findings Related to the Second Sub-Problem

The distribution of students' desire to be a scientist was evaluated on the basis of their gender to determine whether their desire to be a scientist varies depending on their gender. Analysis results are presented in Table 5.

Table 5: Findings related to the gender-based distribution of the desire to be a scientist

		Desire to be a scientist			
		Yes	**No**	**I am not sure**	**Total (N)**
Gender	Male (N)	11	16	0	27
	%	40.74	59.26	0	
	Female (N)	15	10	1	26
	%	57.69	38.46	3.85	
Total (N)		26	26	1	53

As shown in Table 5, 40.74% of male students want to be a scientist, whereas 57.69% of female students want to be a scientist in the future.

3.3. Findings Related to the Third Sub-Problem

The distribution of the students' desire to be a scientist on the basis of their grade level was evaluate to determine how their desire to be a scientist varied based on this variable. Analysis results are given in Table 6.

Table 6: Findings related to the distribution of the desire to be a scientist on the basis of grade level

		Desire to be a scientist			
		Yes	No	I am not sure	**Total**
Grade level	5	8	12	0	20
	%	40.0	60	0	
	6	18	14	1	33
	%	54.55	42.43	3.03	
Total		26	26	1	53

As indicated in Table 6, 40.00% of the fifth grade students and 54.55% of the sixth grade students want to be a scientist in the future. This finding indicates that there is a positive correlation between the grade level of students and their desire to be a scientist.

3.4. Findings Related to the Fourth Sub-Problem

The scores received by students from the questionnaire on attitudes towards scientists were evaluated on the basis of their gender using Mann Whitney U-test. Analysis results are shown in Table 7.

Table 7: Mann Whitney U-Test results of attitudes towards scientists on the basis of gender

Dimension	**Gender**	**N**	**SO**	**ST**	**U**	**p**
Overall scale total attitude score	Male	27	24.98	674.50	296.500	.331
	Female	26	29.10	756.50		

As indicated by the results in Table 7, there is no significant relationship between the attitudes of students towards scientists and their genders ($p > .05$).

3.5. Findings Related to the Fifth Sub-Problem

The scores received by students from the questionnaire on attitudes towards scientists were evaluated using Mann Whitney U-test on the basis of their grade level. Analysis results are presented in Table 8.

Table 8: Mann Whitney U-Test results of attitudes towards scientists on the basis of grade-level

Dimension	Grade level	N	SO	ST	U	p
Total attitude score	5	20	26.80	536.00	326.000	.941
	6	33	27.12	895.00		

As indicated by the results in Table 8, there is no significant relationship between the attitudes of students towards scientists and their grade levels ($p > .05$).

3.6. Findings Related to the Sixth Sub-Problem

The data from the questionnaire were evaluated to determine the attitudes of students towards scientists and their personal characteristics. The arithmetic means of responses to each of the questions in the scale are presented in Table 9 on the basis of gender and grade level. Additionally, mean values of the total attitude scores of students are given at the bottom line of the table.

Table 9: Arithmetic mean scores of the responses to questionnaire items

Questionnaire item	$\overline{X}$	Male	Female	5. grade	6. grade
Scientists are occupied with several different works.	3.79	3.67	3.92	3.55	3.94
Scientists are creative people.	4.00	3.78	4.23	3.90	4.06
Scientists earn a lot of money.	3.71	3.66	3.77	3.90	3.60
Scientists make other people's lives easier.	3.78	3.62	3.95	3.94	3.69
Scientists are supposed to be good problem solvers.	4.00	4.15	3.85	3.80	4.12
Scientists always adopt the best way of solving a problem.	3.66	3.56	3.77	3.35	3.85
Scientists use several different ways to express their opinions.	3.75	3.66	3.85	3.65	3.81
Scientists are supposed to be good in mathematics.	3.76	3.67	3.85	3.60	3.85
Scientists do most of their work using their brain.	3.87	3.44	4.31	3.70	3.97
Scientists explore new information.	4.00	3.67	4.35	3.65	4.21
Scientists design new stuff.	4.02	3.82	4.23	3.85	4.12
Total attitude score mean values	42.34	40.68	44.07	40.89	43.22

The mean values in Table 9 indicate that students in general agree with the statements regarding scientists. There is no statement regarding scientists on which students remained indecisive. The statements most favored by the students include: scientists are creative people, scientists are supposed to be good problem solvers, scientists discover new information and scientists design new stuff. Mean values of the students' overall attitude scores show that they have a high attitude level towards scientists.

The findings shown in Table 9 indicate that, the mean attitude score of female students ($\overline{X} = 44.07$) is higher than that of male students ($\overline{X} = 40.68$); and the mean attitude score of sixth grade students ($\overline{X} = 43.22$) is higher than that of the fifth grade students ($\overline{X} = 40.89$). The findings in Table 7 and 8, however, indicate that this gender and grade-based difference between total attitude scores is not significantly different.

3.7. Findings Related to the Seventh Sub-Problem

The participating students were asked to name their scientist-drawings in the DAS form as a means for understanding how they perceive the gender of a scientist. The name of no renowned scientist was encountered among the students' illustrations of scientists.

The descriptive analysis result as to which gender was indicated by the students' drawings is given in Table 10.

Table 10: Frequency and percentage values regarding the gender of students' scientist-drawings

Gender of the drawn illustrations	N	%
Female	7	13.21
Male	46	86.79
Total	53	100.00

As indicated in Table 10, 13.21% of the students perceived the gender of a scientist as female, and 86.79% perceived the gender of a scientist as male. It can be inferred from these findings that, students, in general, perceived the gender of a scientist as male.

3.8. Findings Related to the Eighth Sub-Problem

The genders of the illustrations drawn by female and male students were evaluated by use of drawings and the names attached to scientists by the students to determine whether the students' perception of a scientist's gender varied depending on their own gender. The results of the gender based analysis of perceptions as to the gender of a scientist are given in Table 11.

Table 11: Frequency and percentage values related to the students' perception of a scientist's gender based on their own gender

Gender of the illustrated scientist	Student's gender			
	Male		Female	
	N	%	N	%
Male	26	100.00	20	74.07
Female	0	0	7	25.93
Total	26	100.00	27	100.00

According to the findings in Table 11, all of the male students drew male scientists, whereas 74.07% of female students drew male, and 25.93% drew female scientists. This finding shows that, female and male students mostly perceive scientists as male individuals.

3.9. Findings Related to the Ninth Sub-Problem

The students' scientist illustrations and their responses to the open-ended questions were evaluated to determine their general perceptions of a scientist. Drawings of the students in addition to their responses to the open-ended questions were evaluated using content analysis. Findings as to each question are given in table form. The

findings related to the student responses to the question "what are the personal characteristics of a scientist" are shown in Table 12.

Table 12: Findings on the perceptions regarding personal characteristics of a scientist

Theme	Code	Student code	Frequency of statement (f)	Frequency based percentage (%)	Percentage (%)
Cognitive characteristics	Smart	S1, S2, S9, S12, S15, S20, S21, S23, S24, S37, S42, S43, S45, S46, S51, S52, S53	17	13.39	35.43
	Hardworking	S2, S4, S5, S7, S11, S12, S16, S17, S18, S19, S20, S25, S30, S32, S34, S37, S38, S39, S41, S46, S50, S51	22	17.32	
	Knowledgeable	S3, S43, S53	3	2.36	
	Creative	S30, S33, S35	3	2.36	
Affective characteristics	Loves students	S17	1	0.79	18.11
	Benevolent	S19, S29	2	1.58	
	Jealous	S19	1	0.79	
	Reliable	S2, S5, S18	3	2.36	
	Happy	S15, S20	2	1.58	
	Angry-short tempered-furious	S23, S42, S45	3	2.36	
	Self-confident	S24	1	0.79	
	Patient	S30	1	0.79	
	Calm	S34, S38, S40, S46	4	3.15	
	Fair	S38, S46	2	1.58	
	Loves reading books	S14, S22, S25	3	2.36	
Working characteristics	Meticulous	S12, S18, S19, 28, S31, S37, S48	7	5.51	6.30
	Teaching new stuff	S14	1	0.79	
Personal Care	Clean	S17, S26	2	1.58	2.36
	Unkempt	S4	1	0.79	
Curiosity in science	Loving to invent	S22, S25	2	1.58	5.51
	Loves experiments	S10, S13, S17, S20	4	3.15	
	Loves science	S39	1	0.79	
Appearance characteristics	Messy hair	S1, S11, S13, S18, S21, S30, S49, S51	8	6.30	32.28
	Glasses/protective glasses	S1, S2, S3, S5, S13, S14, S17, S21, S23, S25, S30, S45	12	9.45	
	Gown	S25, S45	2	1.58	
	Work-wear	S39	1	0.79	
	Helmet/hardhat	S16, S17	2	1.58	
	Astronaut outfit	S38, S41, S43, S44, S50	5	3.94	
	Mustached	S1, S30, S53	3	2.36	
	Bowtie/tie	S1	1	0.79	
	Hairless	S5, S10, S12, S16, S22, S32, S42	7	5.51	
Total		53	127*	100	100

*Frequency of student statements.

Opinions of students as to the personal characteristics of a scientist show that, they mostly referred to scientists' cognitive characteristics (%35.43), affective characteristics (%18.11), appearance (32.28%), working characteristics (6.30%), personal characteristics (2.36%) and their curiosity about science (5.51%). In light of these findings, the most mentioned cognitive characteristics of scientists are their being smart and hardworking. The most mentioned affective characteristics are their being calm, reliable, angry, short-tempered, furious and their bookishness. The most mentioned working characteristic was their being meticulous in their work. In "curiosity for science" theme, the most mentioned characteristic of scientists was their passion for making experiments. The most mentioned appearance characteristics were wearing glasses-protective glasses, having messy hair or no hair.

Some of the direct quotations from the students' opinions are as follows: The statement of student S2 regarding cognitive characteristics theme, smart and hardworking codes; affective characteristics theme, reliability code: *"A very smart, hardworking scientist who gains everybody's trust"*. The statement of student S23 regarding affective characteristics theme, smart code; affective characteristics theme, angry-short tempered-furious code: "*I think he/she is angry at everything and smart"*.

The drawings of students coded S1 and S2 related to the personal characteristics of scientists are given in Figure 2. In these drawings smart, hardworking scientists wearing a gown, glasses, a bowtie with a messy hair are illustrated.

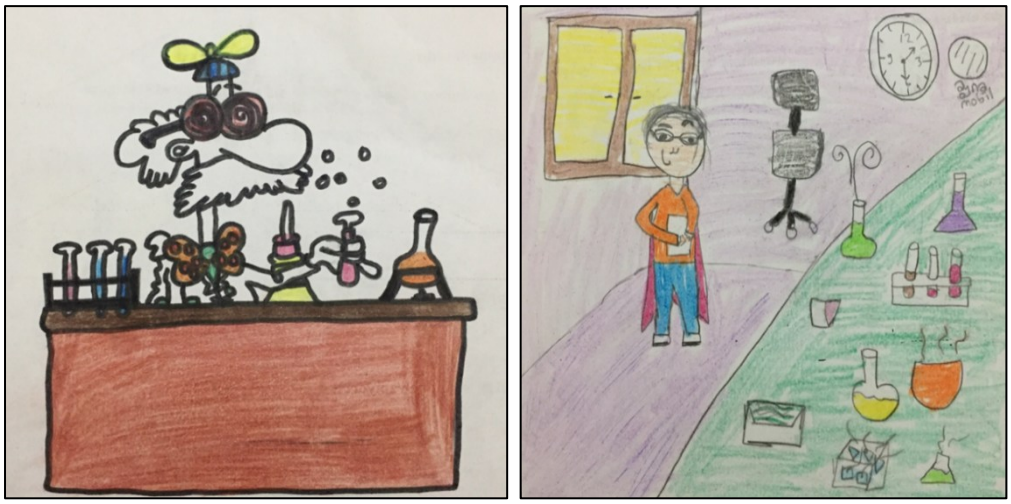


Figure 2: Drawings of the students coded S1 (5th grade) and S2 (6th grade)

The findings as to the responses of the students to the question "How is the working environment of a scientist" are given in Table 13.

Table 13: Findings on perceptions related to the working environment of scientists

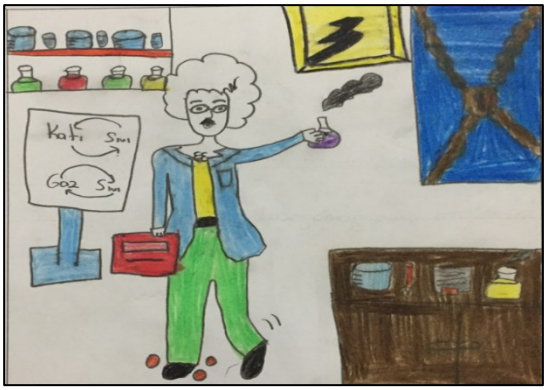
Theme	Code	Student code	Statement frequency (f)	Statement percentage (%)	Percentage (%)
Indoor/closed environment	White room	S15	1	1.19	8.33
	Laboratory	S19, S20, S25, S51	4	4.76	
	Wide	S53	1	1.19	
	Indoor environment	S24	1	1.19	
Ambient air condition	Sunny	S10, S18	2	2.38	7.14
	Hot	S16	1	1.19	
	Airy	S18	1	1.19	
	Dark	S29	1	1.19	
	Cool	S53	1	1.19	
Ambient conditions affected by humans	Crowded	S11	1	1.19	38.10
	Silent-calm	S1, S2, S3, S5, S6, S8, S18, S20, S23, S30, S31, S34, S37, S41, S45, S46, S47, S49, S50, S52	20	23.81	
	Peaceful	S18	1	1.19	
	Full of workers	S32	1	1.19	
	Group work	S4, S5, S7, S9, S15, S17, S39, S53	8	9.52	
	A place of invention	S23	1	1.19	
The order of ambience	Clean	S2, S17, S26, S27, S28	5	5.95	22.62
	Tidy	S3, S16, S27, S28, S33, S39, S40, S46	8	9.52	
	Untidy	S4, S7, S9, S13, S14, S21	6	7.14	
Equipment-status of environment	Full of experiment tools	S17, S20, S21	3	3.57	13.10
	Full of books	S22, S40	2	2.38	
	Somewhere with tv	S22, S32	2	2.38	
	Somewhere with table	S22	1	1.19	
	Somewhere with equipment-tools	S23, S24, S42	3	3.57	
Safety status of environment	Dangerous	S30	1	1.19	2.38
	Comfortable	S35	1	1.19	
Space-aviation related location	Space	S36, S38, S43, S48	4	4.76	7.14
	Vacuum environment	S44	1	1.19	
	Space ship	S48	1	1.19	
Outdoors	Forestland	S15	1	1.19	1.19
Total		53	84*	100	100

*Denotes the frequency of statements.

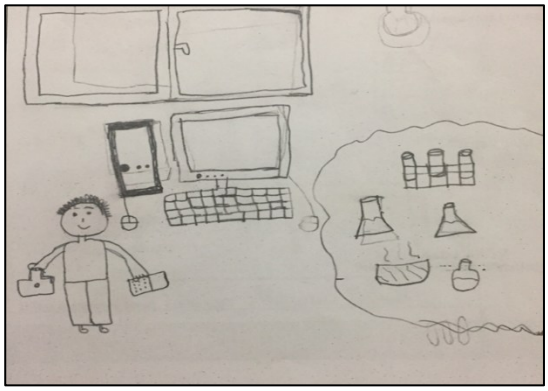
Student statements regarding the working environment of scientists show that, they mentioned indoor locations (8.33%), climatic conditions of the environment (7.14%), the conditions of environment affected by humans (38.10%), tidiness of the environment (22.62%), equipment-status of the environment (13.10%), safety conditions of the environment (2.38%), locations related with space and aviation (7.14%), and outdoor

environments (1.19%). According to these statements, the majority of students stated that, the working environment of a scientist can be silent-calm, clean and tidy, however it can be an untidy environment as well. Again, the majority of students are of the opinion that, scientists work alone in indoor environments such as laboratories. The participating students stated with 9.52% frequency that scientists work with a team.
Some of the direct quotations from student opinions are: The statement of S21 related to "the order of environment" theme, "untidy" code: "*It is really untidy, and full of tubes"*. The statement of S1 related to the "Conditions affected by humans" theme, "silent-calm" code: *"Their working environment is very silent. Because they do stuff that is useful for humans"*.

The illustrations of students coded as S30, S20, S7 and S15, related to the working environments of scientists, are given in Figure 3. In the drawings of S30 and S20, scientists are illustrated alone in laboratory environments full of test tubes; and in the drawings of S7 and S15 scientists are depicted while doing teamwork.

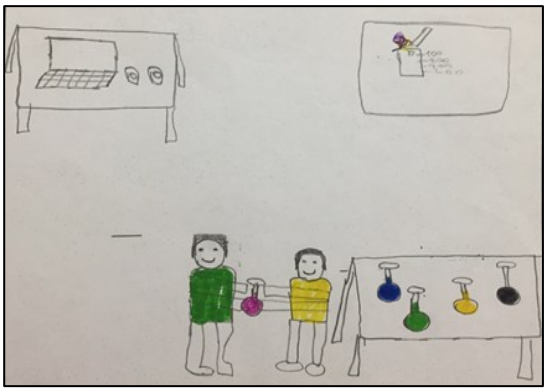


S30 (6. grade)



S20 (6. grade)

S7 (6.grade)



S15 (6. grade)

Figure 3: Drawings of students S30, S20, S7 and S15

The findings related to the responses of the students to the question "What kind of works do scientists do?" are presented in Table 14.

Table 14: Findings related to the perceptions of scientists occupations

Theme	Code	Student code	Statement frequency (f)	Frequency dependent percentage (%)	Percentage (%)
Performing Chemistry-related studies	Chemical	S2	1	1.41	9.86
	Syrup	S2	1	1.41	
	Potion	S2, S7	2	2.82	
	Drug	S24	1	1.41	
	Learning acidic mixture	S25, S52	2	2.82	
Performing Physics-related studies	Colliding atoms	S9	1	1.41	2.82
	Electric wiring works	S37	1	1.41	
Interest in scientific research	Experiment	S11, S15, S17, S19, S20, S31, S32, S45	8	11.27	66.20
	Observation	S11	1	1.41	
	Invention-discovery	S4, S5, S12, S17, S20, S21, S22, S23, S29, S30, S40, S42, S43, S46, S50	15	21.13	
	Scientific research	S10, S15, S39, S41, S47	5	7.04	
	Scientific project	S53	1	1.41	
	Learning new information	S14	1	1.41	
	Making research in space	S36, S38, S41, S44	4	5.63	
	Reading books	S39	1	1.41	
	Discovering ozone layer	S48	1	1.41	
	Making research in computer	S8, S20	2	2.82	
	Interest in biology	S51	1	1.41	
	Interest in chemistry	S51	1	1.41	
	Interest in physics	S51	1	1.41	
	Doing works that facilitates human lives	S1, S3, S21, S30, S49	5	7.04	
Engineering activities	Designing and building space-ships	S18	1	1.41	16.90
	Designing and manufacturing cars	S18, S27	2	2.82	
	Designing and building flying house	S18	1	1.41	
	Designing and manufacturing rockets	S18	1	1.41	
	Designing and manufacturing flying car	S33	1	1.41	
	Test tube design	S10	1	1.41	
	Engineering works	S34	1	1.41	
	Quality control	S15, S16	2	2.82	
	Lamp design	S37	1	1.41	
	Developing technologic tools	S12	1	1.41	

Nature-oriented activities	Travelling the world	S50	1	1.41	2.82
	Protecting environment	S26	1	1.41	
Working by main (body) force	Construction works	S28	1	1.41	1.41
Total		53	71*	100	100

*Denotes the frequency of student statements.

According to the students statements regarding the occupations of scientists, scientists are occupied with scientific works (66.20%), engineering activities (16.90%), chemistry related studies (9.86%), physics related studies (2.82%), nature oriented activities (2.82%), and works that require body force (1.41%). In light of these findings, the majority of students are of the opinion that, scientists are in general occupied with inventions-discoveries, experiments and scientific research to make human life easier.

Some of the direct quotations as to the student statements are as follows: The statement of student S15 regarding the theme "interest in scientific works", "experiment" and "scientific research" codes; "engineering activities" theme, "quality control" code: *"A scientist is the person who makes quality control, scientific research, experiments and who mixes chemicals"*. The statement of S17 related to "interest in science" theme, "experiment" and "invention-discovery" codes: "*Experiments, inventions"*.

The drawings of students S25 and S12 related to the occupations of scientists are shown in Figure 4. These drawings indicate that, scientists are stated to do engineering activities (S12), and experimental activities in laboratories (S25).

Figure 4: Drawings of S12 (6.grade) and S25 (6.grade)

The findings as to the student responses to the question "What is the scientist in your drawing doing?" are given in Table 15.

Table 15: Findings as to the works that scientists in the drawings do

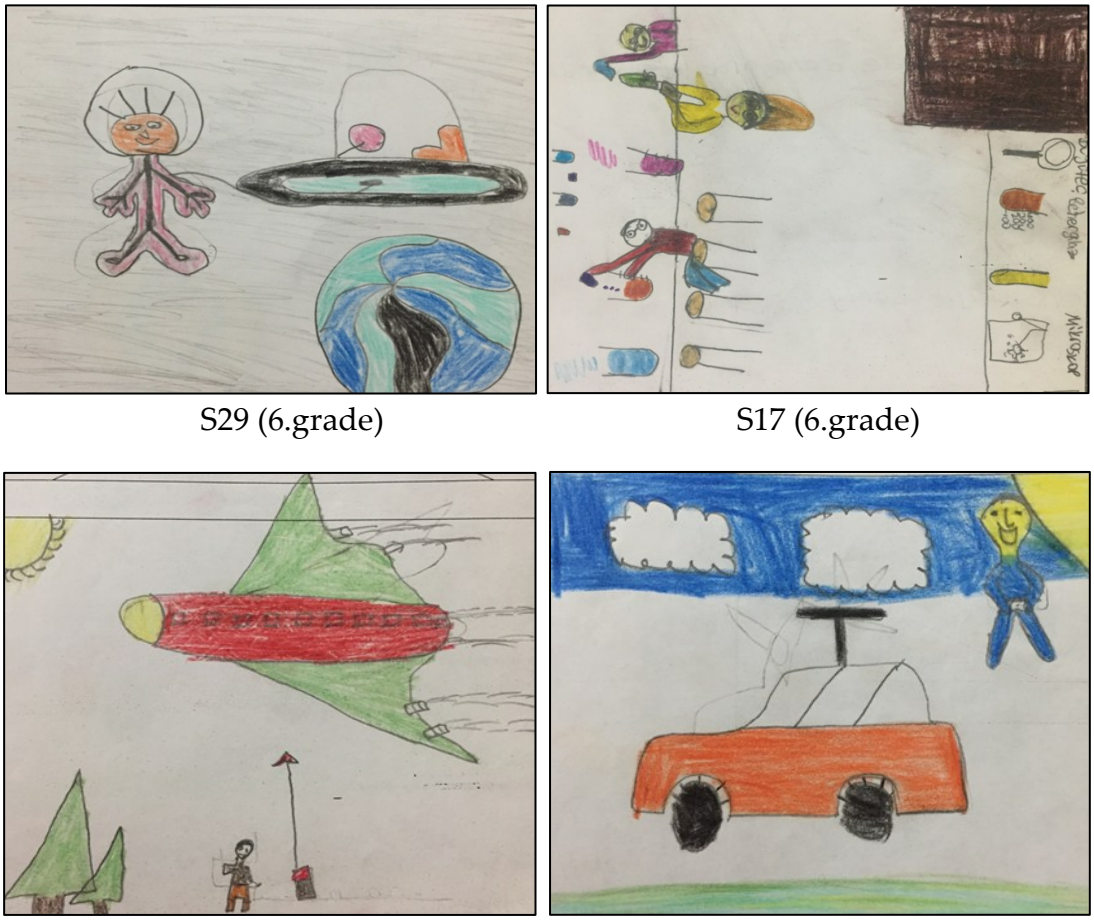
Theme	Code	Student code	Statement frequency (f)	Frequency dependent percentage (%)	Percentage (%)
Engineering activities	Making flying cars	S27	1	1.79	12.5
	Making robots	S22	1	1.79	
	Football field in ozone layer	S48	1	1.79	
	Doing useful things with drugs	S1, S24	2	3.57	
	Converting a phone into a plane	S6	1	1.79	
	Design	S35	1	1.79	
Scientific activities	Making inventions-discoveries	S3, S4, S5, S12, S14, S16, S20, S32, S33, S34, S42, S46	12	21.43	80.36
	Doing space research	S29, S38, S41, S44, S50	5	8.93	
	Doing projects	S4, S13, S18, S53	4	7.14	
	Colliding atoms	S9	1	1.79	
	Making research with microscope	S15	1	1.79	
	Research	S19	1	1.79	
	Experiment	S7, S10, S11, S17, S19, S20, S21, S25, S30, S31, S45	11	19.64	
	Being occupied with science	S47	1	1.79	
	Thinking	S49	1	1.79	
	Reading books	S39	1	1.79	
	Making research on the internet	S8	1	1.79	
	Discovering the world	S36, S43	2	3.57	
	Being occupied with chemistry	S2, S51, S52	3	5.36	
	Learning	S39	1	1.79	
Works that require body force	Construction works	S28	1	1.79	7.14
	Doing electric works	S23, S37, S40	3	5.36	
Total		53	56*	100	100

*Denotes the frequency of student statements.

As shown in Table 15, students stated with their drawings that, scientists do scientific research (80.36%), do engineering activities (12.50%), and do works that require body force (7.14%). According to these findings, the majority of students stated that, the scientist in their drawing makes inventions-discoveries, experiments, scientific projects, and space research.

Some of the direct quotations from student statements are: The statement of S38 about "being engaged in engineering activities" theme "space research" code: *"He/she is makes research in outer space"*. The statement of S12 regarding scientific activities theme, "making inventions-discoveries" code: "*He/she makes both inventions and new stuff*".

The drawings of students S29, S17, S6, and S27 regarding the occupations of scientists are given in Figure 5. In these drawings, scientists are illustrated while making space research (S29), making experiments with a team in laboratory (S17), transforming a phone into a plane (S6) and designing and making a flying car (S27).



S29 (6.grade) S17 (6.grade)

S6 (6. grade) S27 (6. grade)

Figure 5: Drawings of students S29, S17, S6 and S27

4. Results and Discussion

The findings of this research, carried out to determine the 5th and 6th grade secondary school students' perceptions of and attitudes towards scientists show that, the mean attitude score of female students ($\bar{X}$ = 44.07) is higher than that of male students ($\bar{X}$=40.68); and the mean attitude score of sixth grade students ($\bar{X}$=43.22) is higher than that of the fifth grade students ($\bar{X}$=40.89). Analysis results, however, show that these gender and grade-level-based differences in students' attitudes towards scientists are not statistically significant. Likewise, Kibar Kavak (2008) reported that, student attitudes towards science did not differ depending on their gender. In the same research, as opposed to this one, attitudes of students towards science varied depending on their grade level, sixth grade exhibiting the highest attitude and eighth grade exhibiting the lowest attitude. In another research, the opinions of gifted students

related to scientists varied on the basis of gender and grade level (Kemaneci, 2012). In this research, the differentiation in student attitudes towards scientists on the basis of grade levels can be attributed to the insignificant difference between the grade levels resulting in similar ages and science-related knowledge of students.

In the research, students' desire to be a scientist was determined with an open-ended question. 49.10% of the students stated that they wanted to be a scientist, 49.10% stated the opposite and 1.90% stated that they were not sure as to whether they wanted to be a scientist. In a gender-based evaluation, 40.74% of male students stated that they wanted to be a scientist, whereas 57.69% of the female students stated the same. In the drawings, all of the male students drew male scientists, whereas 74.07% and 25.93% of female students drew male and female scientists, respectively. According to these results, although the ratio of female scientists among female students' drawings is only 25.93%, they are more eager to be a scientist in the future as compared to male students. This finding is similar with the results reported by Özdeş (2014) who stated that, 60.00% of both female and male students wanted to be a scientist in the future, although male scientist illustrations prevailed in the students' drawings. In this research, however, male students' desire to be a scientist (40.74%) is lower than that of female students (57.59%). The results of another study showed that, 70.10% of participating students wanted to be a scientist in the future (Nuhoğlu & Afacan, 2011). In this research, the students' desire and reluctance to be a scientist were found to be even (49.10%). In a grade-based analysis, research results show that, 40.00% of the fifth grade students and 54.55% of the sixth grade students wanted to be a scientist in the future. It can be concluded on the basis of this finding that, the desire to be a scientist increased with increasing grade level. As opposed to this result, Nuhoğlu and Afacan (2011) reported that, there was no correlation between grade level and the desire to be a scientist. In their research, the desire to be a scientist was found as 61.50% among fourth grade students, 76.60% among fifth grade students and 72.80% among sixth grade students.

In the research, students depicted scientists with cognitive characteristics such as being smart and hardworking, and appearance characteristics such as wearing gown, glasses or protective glasses, mustache, tie, bowtie and messy hairstyles, or no hair at all. Likewise, in the literature scientists were generally depicted as male individuals (Buldu, 2006; Fung, 2002; Kaya et al., 2008; Losh et al., 2008; Narayan et al., 2013), wearing glasses (Chambers, 1983; Kaya et al., 2008; Kemaneci, 2012; Mead & Metraux, 1957), a mustache (Chambers, 1983; Mead & Metraux, 1957), with messy hair (Mead & Metraux, 1957) and gown (Chambers, 1983; Kemaneci, 2012; Kibar Kavak, 2008; Mead & Metraux, 1957; Narayan et al., 2013; Newton and Newton, 1998; Yontar Toğrol, 2013). Also, scientists' being smart people have been commonly stated by students (Kibar Kavak, 2008; Nuhoğlu & Afacan, 2011).

In the research, the majority of students stated that the working environment of scientists can be silent-calm, clean and tidy, but from time to time, it can be untidy as well. There were also students who defined the working environment as outer space, a place full of experimental equipment or a team-working environment. Other studies in which scientists are illustrated in indoor environments such as laboratory or working

rooms (Chambers, 1983; Fung, 2002; Mead & Metraux, 1957; Narayan et al., 2013; Newton and Newton, 1998), or places which involved laboratory equipment and test tubes (Chambers, 1983; Fung, 2002; Mead & Metraux, 1957)

In this research, the participating students depicted scientists in their working environment with a group of other scientists with a frequency of 9.88%. Likewise, Yontar Toğrol (2013) reported that, 1.54% of students depicted their scientist while working with a group. This result indicates that, majority of students imagine scientists as people who work alone. A similar result was also reported by Lyons, Fralick and Kearn (2009).

In the research, the most mentioned activity of scientists was "scientific research activities" with 66.20% frequency. These activities involve invention-discovery (21.13%), experiment (11.27%), scientific research (5.63%), scientific research (7.04%), works that facilitate human life (7.04%), doing research in the space (5.63%), and observation (1.41%). The second most mentioned activities performed by scientists were stated by the students as the "engineering activities". Some of the activities in this theme involve car design and manufacturing (2.82%), quality control (2.82%), designing and building space ships (1.41%), designing and building flying houses (1.41%) and developing technological devices (1.41%). Similarly, Song and Kim (1999) also reported that, 33.60%, 28.60%, 13.60%, 1.80% and 1.60% of students illustrated scientists while they were doing research, experiments, inventions, observations and giving lecture, respectively. In another research, students stated that, scientists love to make research, and their research fields mainly consist of physics and chemistry (Nuhoğlu & Afacan, 2011). The activities in "engineering activities" theme in this research indicate that, students fail to distinguish between the works carried out by scientists and engineers. No similar finding was encountered in the literature.

In the research students stated with 80.36% statement frequency that the scientists they drew carried out scientific activities. The activities in this theme involve invention-discovery (21.43%), experiment (19.64%), space research (8.93%) and doing scientific projects (7.14%). This research finding is consistent with other research results (Nuhoğlu & Afacan, 2011; Song & Kim, 1999). The findings of this research, stating that the drawn scientists conduct engineering activities (12.50%) and often perform works that require body force (7.14%), were not encountered among literature results.

The results obtained using the questionnaire show that, the majority of participants imagine scientists as creative, problem-solving individuals who discover new information and design new stuff. In general, students did not state any opinion on which they remained indecisive or they significantly differed. Similarly, Lyons, et al. (2009) reported that, students perceived scientists as creative individuals who discover new information, adopt the best way to solve a problem, perform multiple tasks, use different ways of communication, earn a lot of money and use their brains in their works. As opposed to the findings of the present research, in their research, scientists were defined, mostly by female students, as people who were very likely to be a boss, that earn a lot of money, work alone, and do most of their work with their hands (Lyons, et al., 2009).

5. Recommendations

The participants' general perceptions and desires to be a scientist are not in adequate levels in the present research. This, however, does not necessarily mean that they will change their minds in the future. Students' opinions on career selection may vary depending on their personal development and experiences. Some of the renowned scientists, for instance, did not have much interest in science in their elementary and secondary school ages. In later ages, however, they tended towards science after discovering their fields of interest and skills, and even paved the way for some of the very important inventions (Brockman, 2006). Therefore, long-termed longitudinal studies could be performed with respect to the desires of students to be a scientist in the future.

Some of the stereotyped opinions of students towards scientists, reported in previous studies, were also detected in the present research. The quality of received education, course books, teacher behaviors, gender and personality of teacher, television, science fiction books and cartoons are the effective factors for development of the student perceptions related to scientists as from their kindergarten and primary education years (Buldu, 2006; Türkmen, 2008). Course books should be organized so as to include the content to develop positive attitude towards scientists (Bağ, 2013; She, 1995), the qualities that should be possessed by scientists should be emphasized, female figures should be mentioned as much as male figures, life stories of female scientists should be told to underline the fact that science is not an occupation merely performed by male individuals. It should be also emphasized through organizing outdoor activities, field trips, observations, and studies that, scientists work not only in laboratories but also in other environments, and that scientific work is a teamwork rather than an individual endeavor. (Kibar Kavak, 2008).

Lives and experiences of students play a crucial role in development of their perceptions and attitudes towards science and scientists. Accordingly, environments in which students feel like scientists and use their process skills should be established.

Teachers undertake a major role in establishment of such environments. Experiments carried out in laboratories by students in cooperative groups throughout the research period will have a positive effect on their perceptions and attitudes towards scientists. Likewise, scientists can be introduced to students, trips could be organized to universities and various scientific research centers, or scientists can be invited from these institutions to interact with students as a means for developing positive perceptions and attitudes towards scientists.

In this study, students were found to confuse the working fields of scientists and engineers. Science and engineering applications and engineering design skills courses were included in Turkish Science Teaching Curriculum in 2017. Inclusion of an integrated approach to science, technology, engineering and mathematics into the educational process can help students in distinguishing between the works performed by engineers and scientists. This way, students can be assisted in discovering their own

skills and gain an awareness regarding their career as from the first years of their education.

Although, this study was carried out with limited number of students receiving education in a few grade levels, the obtained findings are valuable for reflecting the opinions of this age group towards scientists. It is also thought to be necessary to carry out similar studies with different study groups and determine the variation of findings from a specific study group with increasing grade level. Numerous studies have been performed on perceptions of students from several age groups about scientists as from the year 1957. Therefore, a vast amount of knowledge is available in this field. In this respect, meta-analysis studies for compilation and analysis of all related research could be performed.

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