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Gender Differences in Turkish Primary Students' Images of Astronomical Scientists: A Preliminary Study with 21st Century Style

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Abstract

This study investigated the images of astronomical scientists held by Turkish primary students by gender. The Draw an Astronomical Scientist Test was administered to 472 students from an urban area. A Chi-Square Test of Independence was used to test for statistically significant differences between gender groups. Significant differences were found between girls' and boys' images of astronomical scientists in terms of some aspects. It is thought that the findings of this research will contribute to the development of universal astronomy education, to the researchers studying on gender issues, cultural diversity, and also to the international literature on astronomy education.

1. INTRODUCTION

Astronomy is one of the oldest sciences known to exist (Osborne 1991; Bailey and Slater 2003) and recurrent contemporary issues are presented in the mass media where news related to comets, new stars, satellites, space tests, etc., frequently appear (Pena and Quilez 2001). An outcome of this was the introduction of astronomy in the curriculum of primary and secondary education, either as part of science courses or as separate discipline. As indicated by Percy (1998), education is important to astronomy because it affects the recruitment and training of future astronomers and astronomy educators. It also affects the awareness, understanding, and appreciation of astronomy by the taxpayers who support us. Astronomy is also important to education—irrespective of the needs of the astronomical profession.

Children at school are the carriers of a new space age. They are the future space technology users, and some of them will be the future policy makers, planners, scientists, and politicians. Thus, it is important to educate children on astronomy and space science as soon as possible at a young age. For better learning and teaching about astronomy and space science issues, we must primarily determine current children's images of science and scientists in astronomy.

One of the goals of astronomy education is that students should regard a career in astronomy as an acceptable and viable option. Students' occupational preferences and career aspirations are strongly linked to their images of particular occupations (Gottfredson 1981; Palmer 1997). The importance of this link between occupational image and career is generally accepted (Maoldomhnaigh and Mholain 1990) and, as a result, a considerable amount of research attention has focused upon the exploration of students' images of scientists.

It is also common knowledge that students bring their own images and understandings about science to the classroom (Driver, Guesne, and Tiberghien 1985; Osborne and Freyberg, 1985; Scott and Driver 1997). In this context, the goals of an image study are to facilitate educators, to promote the awareness, appreciation, and knowledge of children's readiness, and to provide a view for starting an education. A description of students' present images of astronomical scientists in a country might help give direction to the future. In this study, the images of astronomical science and scientists of Turkish primary students were examined and the contexts and implications of differences by gender of a study of the implementation of the new science curriculum were explored.

1.1. The Turkish Astronomy Curriculum

The interpretation of the results of an image study is related to the context of the existing curriculum. Thus, a short description of the Turkish astronomy curriculum is given in this section. The Turkish school system is divided into the two following levels: primary schools (K–8), covering the period of compulsory education and secondary school (9–12). The curriculum in Turkey is centralized. Not only does the Turkish government determine the national curriculum standards and content, but it also centralizes the textbooks, the teaching materials, and the pace of teaching. All schools throughout the country must follow the same curriculum and use the same educational materials authorized by the Ministry of Education. Since 2004, Turkey has promoted reforms under the European Union Standards in all educational fields, including science and technology education, such as in instructional methods, the educational system, policy, teacher training, finance, and educational system. In this context, science and technology education themes were changed. The new science and technology education themes include scientific literacy, integrated curriculum, cooperative learning, thematic approach, constructivism, classroom management, assessment and evaluation, equity, science-technology-society, scientific skills, educational technology, attitudes and values, and learning styles. This study was focused on astronomy education as a part of science and technology education at primary school level. In terms of K–8 astronomy, a careful overview of the *National Science Education Standards* suggests major astronomy objectives.

Astronomy is a major component of the life science and science curriculum in Turkey throughout the different levels of primary education. These objectives include describing changes over time and the objects and motions of the sky, day and night, seasons, (grades K–3), the relationship between the sun, earth, and moon, and our planet's shape and size, (grades 4 and 5), and the characteristics of gravity, the solar system bodies, stars, and galaxies (grades 6–8). Although astronomy topics have appeared in school science curriculum at all levels, the number of high schools that offer an astronomy course as a separate course is very small. There are only a few universities that have an astronomy and space science department. Today few teachers have had high school or college astronomy. Probably owing to this lack training, science teachers at all grade levels lack confidence in teaching its topics.

Thus the astronomy units in the primary and secondary school curricula are often not taught effectively. Students are therefore deprived of the realization of one of the most fundamental and unifying of science subjects—orientation in space and time and the nature of the universe beyond our planet. In 2006–2007 academic years, to eliminate this defect, Turkish education policy makers offered an astronomy course for preservice science teachers' training programs. This means that every preservice primary science teacher must take an astronomy course as a compulsory requirement during their college education from 2006–2007 academic years onward.

1.2. Gender Differences in Images of Science and Scientists

Although the primary study on students' images of scientists was conducted by Mead and Metraux (1957), there has been a growing gender-related focus on students' images of science and scientists since the 1980s. Using questionnaires with open-ended questions, Mead and Metraux (1957) discovered that the popular picture of the scientist was of a white male with facial hair, wearing spectacles and a laboratory coat, working at the bench with chemical apparatus. In their study, the principal aim was not to explore the students' images of science and scientists by gender but their study has given us a view about it. Although the subjects in their study comprised both gender groups, most of the students perceive a scientist as being a white male.

Later, the stereotypic "mad scientist" image of scientists has been documented through a number of studies such as the "draw-a-scientist" task (Chambers 1983). Chambers' initial study of a large sample of elementary students found that less than 1% of the 4807 students drew a female scientist (Chambers 1983).

Fort and Varney (1989) obtained drawings from 1600 students spanning grades 2–12. Of those drawings, only 165 were of female scientists, even though 60% of this sample was female students. In addition only six of the drawings of female scientists were drawn by male students.

In 1990s, Huber and Burton (1995) using a chi-square analysis reported that boys were more inclined to draw a picture of a scientist that included a male with funny hair, weird smile, wild eyes, robotlike features, and scars than were girls. They also found males were more likely to draw a scientist as being a white male. Only 13 males out of 105 depicted a scientist as a being a female. Females in the study were equally as likely to draw a male scientist as a female scientist.

Barman (1997) conducted a study in the District of Columbia with 1504 students from 23 states, and three additional countries, and it was revealed that students still perceive scientists as white males with laboratory coats, eyeglasses, and facial hair. Even though there was equal representation from both genders in the study, only 25% of the middle school students included a female as a scientist in their drawing.

Song and Kim (1999) investigated Korean students' images of the scientists. In their study, the data, quantitative and qualitative, from the responses of a total of 1137 from the different groups (ages 11, 13, and 15) were analyzed to calculate the relative frequencies of some identified patterns of responses and to make comparisons between different genders and different age groups. They found that there were some differences between the gender groups: girls more frequently mentioned "experiment" while boys did "research." In addition, nearly three quarters of the students (74.4%) identified the scientists as male while only 16.1% did as female. There was a clear difference according to the respondents' gender: in trend girls drew a much higher proportion of female scientists. In 2001, Gounselin (2001) conducted a study on images of scientists held by 373 middle school students and found that male students depicted scientists as males, but females depicted scientists as both male and female.

As mentioned above, over the past 50 years, a growing body of research has been conducted on people's images of science and scientists. Much of this research has focused on children's images in general science context rather than a specific science context such as biological science and scientists, chemical science and scientists, physical science and scientists, and astronomical science and scientists. There is a lack of information in how students view astronomical science and scientists. This study is aimed to provide descriptive information about students' images of astronomical science and scientists in terms of various aspects including stereotype images, alternative images, and additional images by gender.

2. METHOD

2.1. Study Participants

The present study reports data from a sample of Turkish students. A total of 472 primary school students from five schools participated in the study [237 boys (∼50%) and 235 girls (∼50%)]. The schools are located in an urban area. Teachers were selected based on their willingness to volunteer. Students who participated in the study were randomly assigned to their classes by school administration prior to the opening of school and the initiation of the study. Teachers and the researcher gave the instrument during their science classes and provided students with unlimited time to complete all items.

2.2. Research Design

This study employs a survey design using an instrument to collect the images of Turkish primary students in astronomical science.

2.3. Instrumentation

The instrument survey that was used in this study included two subtests. Draw an Astronomical Scientists Test (images)" and "What about Learn (interests)," designed by the author based on previous studies. The context of the instrument in terms of development, description, and analyses is explained below.

The Draw an Astronomical Scientist Test (DAAST) is a drawing test. Drawing is a very powerful instrument in the analysis of children's imagery. In this study, the drawing activity used to elicit student images of astronomical science and scientists is a modified version of Chambers' (1983) draw-a-scientist test (DAST). DAST was first utilized by Chambers (1983) to examine stereotypic images of scientists among school children. Chambers' initial study examined the strength and presence of "modern sanitized" and "older mythic" stereotypic images of the scientist in 4807 children's (ages 5–11 years) drawings that were collected from 1966 to 1977. After Chambers' study, variations of the DAST have been utilized in the United States and Canada (e.g., Parsons 1997), Ireland (e.g., Maoldomhnaigh and Hunt 1988), Finland (e.g., Raty and Snellman 1997), England (e.g., Brosnan 1999), Turkey (Buldu 2006; Korkmaz 2004; Togrol 2000), Korea (e.g., Song and Kim 1999), and Taiwan (e.g., She 1998) with similar results.

The Draw a Scientist Test Checklist (DAST-C) developed by Finson, Beaver, and Cramond (1995) was adapted to design scoring rubric. The seven standard images of a scientist identified by Chambers (1983) were adapted as the first section of the DAAST checklist. The second section of the DAAST checklist represents the alternative images of an astronomical scientist. The alternative images in DAST-C (Finson, Beaver, and Cramond 1995) were included and the researcher added two indicators, namely, gender and age. These indicators and specific descriptors were added in the DAAST checklist because they showed up frequently in the drawings of students during a pilot test. A third category, Additional Images of an Astronomical Scientist, contains three indicators, namely, emotions of an astronomical scientist, natural setting(s) of work, and nature of scientific work as shown Table 3. The students' drawings were coded into a set of categories as shown Tables 1–3. Chi-square analyses were conducted to determine if gender differences in student images were present.

2.4. Procedure

The DAAST was administered in a group by the format by the researcher who had visited the classroom 4 weeks previously as a limited participant observer—not in any type of instructional role. Students were each given a piece of white paper and provided with crayons, colored pencils, and markers in a variety of colors that could be used to depict different skin colors if the students chose to do so. Students were also asked to put down their class level, age, and sex—but not their names—on the paper.

In standardized fashion, children were instructed to "draw a picture of an astronomical scientist at work." Each student spent the entire 50 min class period carefully completing his or her drawing. Some students inquired as to what they should draw, and they were assured that whatever they drew in response to this assignment would be fine. Based on previous experience with administering this test in other school settings, this was a common question.

Over the following weeks students were interviewed and asked to describe the details of their picture of the scientist. Student comments were recorded on paper to use later in scoring the drawings. Interviews began by simply asking students to tell about their pictures. The DAST-C was used as a guide during the interviews, and items that would not be anatomically evident to the scorer just by looking at the drawings were asked about specifically during the interviews. For example, a common ambiguous feature of the drawings was the age of the scientist. To clarify this item, students were asked if the scientist was as old as they were, as old as their parents were, old as their grandparents, or other elders that they knew. This seemed to make it easier for students to explain their intention in this particular category.

Using the DAST-C (Finson, Beaver, and Cramond 1995) the drawings were scored initially by the researcher and then by a science education professor. Notes collected from the interviews with students resulted in 100% agreements in the scoring of the drawings using the checklist indicators.

3. FINDINGS AND DISCUSSIONS

The analyses of the drawings reveal that an astronomical scientist is perceived by the Turkish primary school students in this study as a mosaic of the standard image of scientists and alternative images and have additional characteristics specific to scientists who study astronomy.

3.1. The Standard Image of an Astronomical Scientist

All seven indicators of the standard images of a scientist (Chambers 1983) were present in the subjects' drawings of an astronomical scientist. Table 1 shows the frequencies, percentages, and chi-square results of indicators of a standard image of an astronomical scientist drawn by the gender of subjects.

Table 1. Pretest and posttest frequencies, percentages, and chi-square for DAAST

Stereotypical images of a scientist (from Chambers 1983)	Boy ($n=237$) f (%)	Girl ($n=235$) f (%)	df	χ^2	P	Level of significance
1. Laboratory coat	24 (10.12)	36 (15.31)	1	2.86	0.90	NS
2. Eyeglasses	30 (12.65)	59 (25.10)	1	11.95	0.01	a
3. Facial growth of hair	55 (23.20)	56 (23.82)	1	0.00	0.95	NS
4. Symbols of knowledge	31 (13.08)	65 (27.65)	1	15.48	0.00	a
5. Symbols of research	174 (73.41)	122 (51.91)	1	23.33	0.000	a
6. Technology	216 (91.13)	200 (85.10)	1	4.07	0.04	a
7. Relevant Captions	28 (11.81)	4 (1.70)	1	19.09	0.00	a

[a] $p \leq 0.05$.

As indicated in Table 2, there were statistically significant differences by gender for five indicators, including eyeglasses, symbols of knowledge, symbols of research, technology, and relevant captions of standard images. More girls in this study depicted an astronomical scientist wearing eyeglasses $[x2(1, N=472) = 11.95, p=0.01]$ and using knowledge symbols $[x^2(1, N=472) = 15.48, p < 0.01]$ including principally books and filling cabinets than boys (see Figures 1–4).

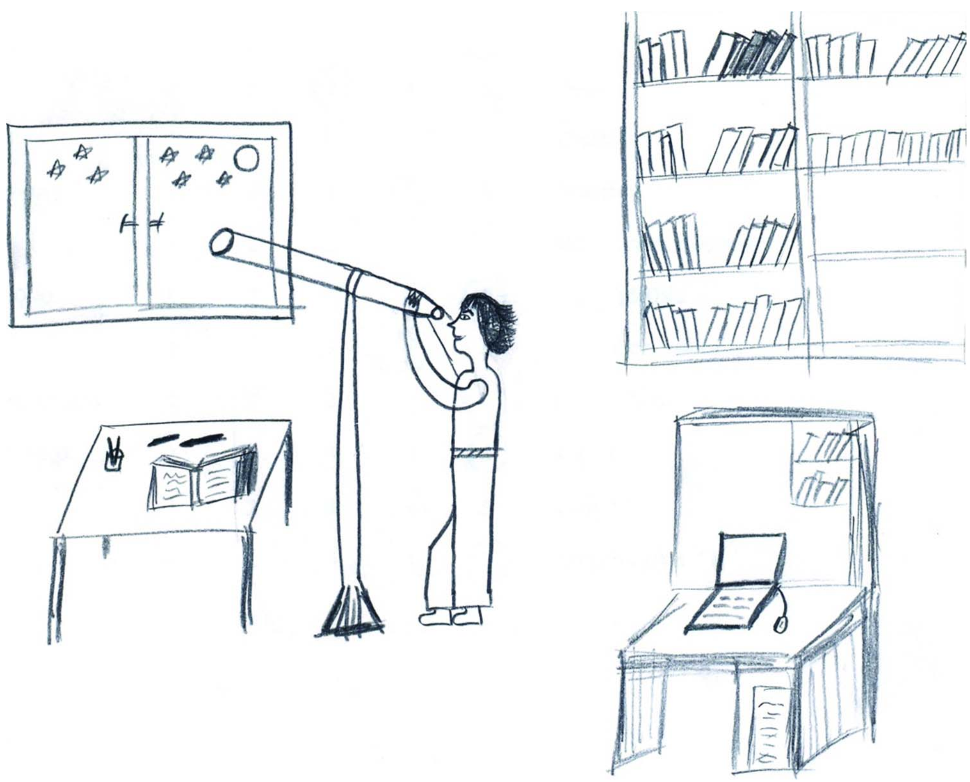

Figure 1. An astronomical scientist's image with daily clothes, knowledge and technology symbols drawn by a seventh grade girl

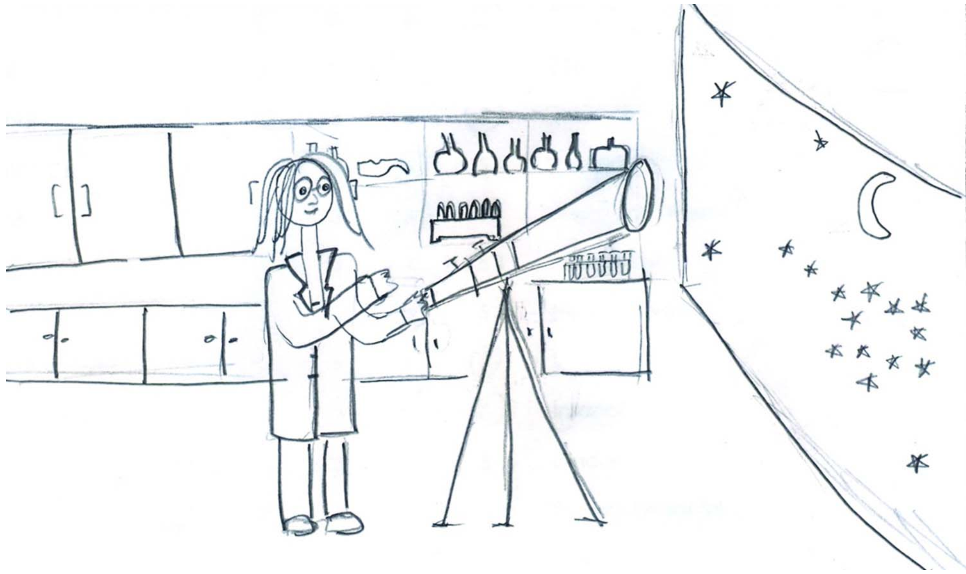

Figure 2. A female scientist image with laboratory coat, eyeglasses, and research symbols drawn by a seventh grade girl

A few participants in each gender group drew globes (see Figures 3 and 4), maps, mathematical instruments such as compasses, ruler, protractor, etc., as knowledge symbols instead of books and filling cabinets.

Figure 3. A sample drawing showing scientist's image with smiling face and using globe, laboratory equipment, telescope, and computer, drawn by an eighth grade boy

Although there is a statistically significant difference [$x^2(1, N=472)=4.07, p<0.05$] between the boys and the girls in favor of the boys, most of the participants in both groups drew an astronomical scientist using technology and the products of science, such as computers, microscopes, and telescopes (e.g., see Figures 1–4 and 6–8).

Figure 4. A sample drawing showing setting work for an astronomical scientist's image with using knowledge and technology symbols drawn by a sixth grade girl

A telescope was observed in most of the drawings (96%). The participants in this study considered a telescope in their drawings as an important technological tool which is used by a scientist who studies astronomy. This result is consistent with previous findings. Chambers (1983) reported younger children were most likely to draw laboratory coats, eyeglasses, growth of facial hair, and laboratory equipment. Middle school students (this school level is equal to the second level including grades 6–8 of primary school in Turkey) added more sophisticated items such as microscopes, telescopes, and computers to the drawing. Additionally, more boys (11.81%) than girls (1.70%) drew the scientist using relevant captions including formulae, taxonomic classifications, and the "Eureka!" syndrome.

The results showed that there were no significant differences for two stereotypes including laboratory coat [$x^2(1, N=472)=2.86, p>0.05$] and facial growth of hair [$x^2(1, N=472)=0.00, p>0.05$]. The participants in this study drew an astronomical scientist wearing a space suit (see Figures 4 and 5), daily clothes, and magician suits, except for a laboratory coat (see Figures 1, 4, and 7). Contrary to earlier studies (e.g., Barman 1997; Fort and Varney 1989; Chambers 1983; Mead and Metraux 1957), most of the participants in this study did not depict scientists as wearing laboratory coat, wearing eyeglasses, and with facial hair.

This result can be explained in the context of the study and represented the role models in astronomy in mass media. This study is focused on the students' images of a scientist who studies a specific area of science—astronomy—instead of general science. Thus the participants drew specific characteristics related to astronomy instead of general scientific characteristics. In addition, the famous astronomers' physical appearances, including Yuri Gagarin, Neil Armstrong, Buzz Aldrin, and others are different from other scientists' (e.g., Albert Einstein, Marie Curie, and Isaac Newton) physical appearances. They did not wear laboratory coats, wear eyeglasses, and have facial hair. They have been generally seen as wearing space suits in mass media by students. As a result of this, students may draw a scientist who studies astronomy as wearing a space suit and other clothes instead of a laboratory coat (see Figures 1, 4, 5, and 7).

Figure 5. A male scientist image with space suit and outdoor activity (space walking) drawn by sixth grade girl

3.2. The Alternative Images of an Astronomical Scientist

When the drawings were analyzed for alternative images, it was interesting to observe the candor with which the subjects drew many alternative images of a scientist that helped define their perceptions of an astronomical scientist. Six indicators assessed in this category are (1) gender, (2) age, (3) indications of danger, (4) presence of light bulbs, (5) mythic images, and (6) indicators of secrecy. Indicator 8, "gender," was expanded to "male," "female," and "gender-neutral." Indicator 9, "age of scientist," had three choices that included "young aged," "middle aged," and "elderly" to accommodate the subjects' perceptions. Table 2 summarizes the responses to the indicators on the alternative images on an astronomical scientist.

Table 2. Pretest and posttest frequencies, percentages, and chi-square for DAAST

Alternative images of a scientist (adapted from Finson, Beaver, and Cramond 1995)		Boy ($n=237$) *f* (%)	Girl ($n=235$) *f* (%)	*df*	χ^2	P^*	Level of significance
8. Gender	Male	200 (84.38)	98 (41.70)	1	92.37	0.00	a
	Female	8 (3.37)	112 (47.65)	1	122.04	0.00	a
	Gender-neutral	19 (8.01)	25 (10.63)	1	0.95	0.32	NS
9. Age	Young aged	52 (21.94)	93 (39.57)	1	17.51	0.00	a
	Middle aged	146 (61.60)	122 (51.91)	1	4.51	0.03	a
	Elderly scientist	39 (16.45)	20 (8.51)	1	6.81	0.00	a
10. Indications of danger		1 (0.42)	0 (0)	1	0.99	0.31	NS
11. Presence oflight bulbs		1 (0.42)	2 (0.85)	1	0.34	0.55	NS
12. Mythic images		2 (0.84)	1 (0.43)	1	0.32	0.56	NS
13. Indicators of secrecy		2 (0.84)	2 (0.85)	1	0.00	0.99	NS

[a] $p \leq 0.05$.

As indicated in Table 2, most of the boys (84.38%) drew male scientists. There were only 8 out of the 237 boys who did not draw male scientists. Also, more boys (61.60%) in this study drew middle aged scientists compared to girls (see Figure 6), [$x^2(1, N=472)=4.51, p<0.05$]. Nearly half of the girl participants (47.65%) in this study drew female scientists, $x^2(1, N=472)=122.04, p<0.01$. Likewise, Maoldomhnaigh and Mholain (1990) considered the effects of test administration instructions, eventually changing the DAST instructions to "Draw a Man or Woman Scientist." Stated thusly, 367 children (299 females and 68 males) between the ages of 11 and 16 years provided drawings. Although boys in this sample almost exclusively drew males, 49% of the girls drew females. Brosnan (1999) modified the task by reframing it as a "draw-a-computer-user test." For Brosnan (1999), whose sample consisted of 395 children ages 5–11 years, males performed similar to males who complete the standard DAST. Interestingly, 70% of the females drew a female computer user, while only 4% of males drew a female computer user. Similarly, Knight and Cunningham (2004) used "Draw an Engineer Test" (DAET) including written and drawn responses to assess students' images of engineering. This test was modified from DAST by researchers. In their study, of the 64 drawings with evidence of gender, 61% were male characteristics and 39% were female. Females were more likely to draw females than males.

The findings on gender of an astronomical scientist in this study underscore the importance of role models, both in person and as represented in textbooks, magazines, and television programs. Role models impact the cognitive learning of all students. Perhaps, television presentations of female scientists who do astronomy may have brought about awareness that there are female scientists in astronomy. Future studies might aim at further defining the determination of how students determine gender notion of astronomical scientists.

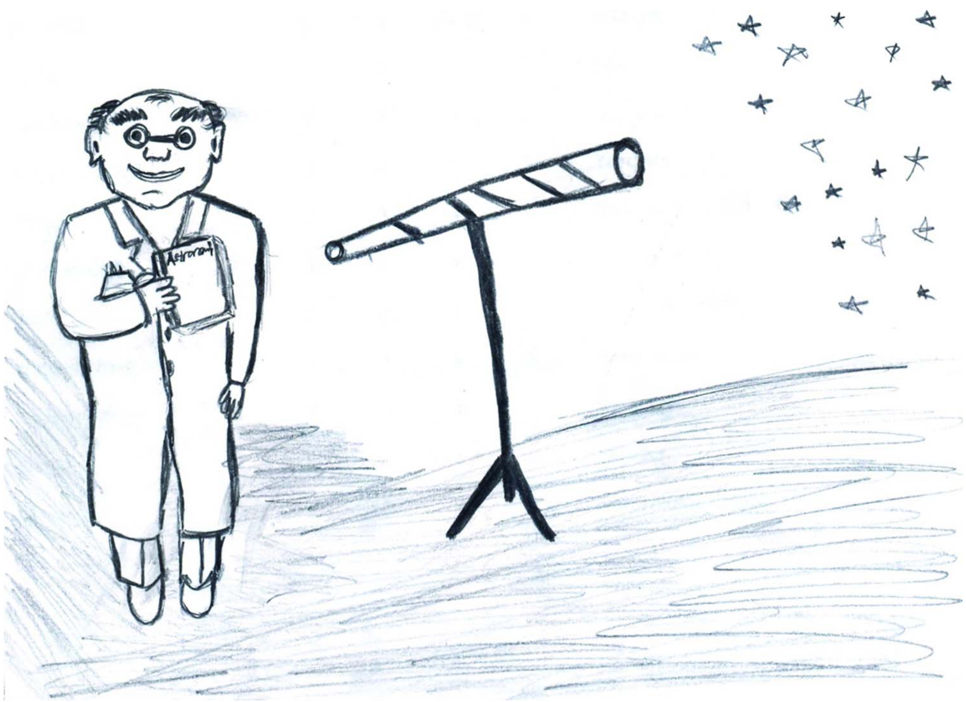

Figure 6. A middle aged and male scientist image with laboratory coat, eyeglasses, knowledge and technology symbols drawn by an eighth grade boy

The boys continue to depict scientists as males. These results prove that there has not been much progress over the 50 years in developing males' perspectives about gender of scientists. In contrast, the girls depict scientists as both male and female. These findings are not consistent with earlier findings (e.g., Finson, Beaver, and Cramond 1995; Chambers 1983; Mead and Metraux 1957). In earlier findings, girls depicted scientists as males. These findings conclude that are have been successful efforts to change how girls depict or view the gender of scientists.

Although there was statistically a significant difference in favor of boys, the middle aged scientist was the popular image drawn by both groups. This finding may be explained by the fact that the age of the an astronomical scientist is subconsciously coupled with outdoor activities such as space walking and collecting, observing, and recording data all day.

Earlier, many researchers have analyzed students' depictions of age in their drawings of scientists. Thomas and Hairston (2003) investigated students' images of an environmental scientist by using Draw an Environmental Scientists Test which was adapted from Chambers' DAST. In their study, the middle age scientist was observed as a popular image by both gender groups. There were only a few drawings depicting indications of danger, presence of light bulbs, mythic images, and indicators of secrecy in both groups.

3.3. Additional Images of an Astronomical Scientist

The additional images specific to an astronomical scientist were depicted in three indicators of the DAAST checklist. These indicators are (14) emotions depicted, (15) natural setting(s) of work, and (16) nature of scientific work. Indicator 14, the emotions of an astronomical scientist, was expanded to include joy, hope, and sadness. Indicator 15, the settings of work, was expanded to include common environments in which astronomical scientists perform their work. Finally, indicator 16 serves to record the nature of scientific work including science process skills drawn and described by subjects. The indicator named "type of scientist," which existed on the original checklist developed by the Thomas and Hairston (2003), was not used in this study. Generally, the type of scientist was generic; a small percentage of the pictures drawn depicted an astronaut. Table 3 summarizes the additional images of an astronomical scientist analyzed from the drawings of the subjects.

Table 3. Pretest and posttest frequencies, percentages, and chi-square for DAAST

Additional images of an astronomical scientist (adapted from Thomas and Hairston 2003)		Boy ($n=237$) f (%)	Girl ($n=235$) f (%)	*df*	X^2	*P*	Level of significance
14. Emotions depicted	Emotions of joy/hope	125 (52.74)	102 (43.40)	1	4.12	0.04	[a]
	Emotions of sadness	36 (15.18)	19 (8.08)	1	5.78	0.16	[a]
	No emotion depicted	76 (32.06)	114 (48.51)	1	13.26	0.00	[a]
15. Natural setting(s) of work	Indoor	3 (1.26)	1 (0.43)	1	1.02	0.31	NS
	Outdoor	129 (54.43)	110 (46.80)	1	2.74	0.09	NS
	Combination of indoor and outdoor	103 (43.45)	124(52.76)	1	4.09	0.43	NS
16. Nature of scientific work	Observing	95 (40.08)	117(49.78)	1	4.49	0.34	NS
	Measuring	1 (0.42)	1(0.43)	1	0.00	0.99	NS
	Testing samples with scientific instruments	3 (1.26)	3(1.27)	1	0.00	0.99	NS
	Collecting data	28 (11.81)	4(1.70)	1	19.09	0.00	[a]
	Experimenting	18 (7.59)	13(5.53)	1	0.81	0.36	NS
	Reporting	22 (9.28)	39(16.59)	1	5.60	0.02	[a]
	Working cooperatively	46 (19.40)	24(10.21)	1	8.33	0.04	[a]
	Space Walk	61 (23.73)	12(5.11)	1	38.41	0.00	[a]

[a] $p \leq 0.05$.

The indicator for "emotions" helps to assess the expressions depicted in the drawings. In most of the boys' drawings (52.74%), they express joy and hope that an astronomical scientist discovers new things about space (see Figure 5). More boys (15.18%) also depicted scientists as sad than the girls (19, 8.08%), $x^2(1, N=472)=5.78, p<0.05$. More girls (48.51%) than boys (32.06%) gave no emotion to the scientists in their drawings, $x^2(1, N=472)=13.26,\ p<0.01$.

The most popular natural settings of scientific work drawn by the subjects were outdoor and combination of indoor and outdoor in both groups (see Figures 1, 2, and 4).

Only a few participants in both groups drew an astronomical science as an indoor occupation. These results are also not consistent with earlier findings. In earlier studies, e.g., Barman 1997; Fort and Varney 1989; Chambers 1983; Mead and Metraux 1957), students depict science as an indoor occupation (see Figure 3). This result can be explained by the nature of astronomy. An astronomical scientist investigates about sky objects, stars, planets, meteors, etc. Thus he/she must use *both outdoor* and *indoor* sources in his/her studies. This finding is similar to what Thomas and Hairston (2003) reported. In their study, they reported the most popular setting of work of an environmental scientist drawn by subjects as water environments, forest where wildlife abounds, and wetlands surrounded by trees and vegetation.

In terms of four indicators in the nature of scientific work, there were no statistically significant differences in gender groups. These indicators are, namely, observing $[x^2(1,N=472)=4.49, p>0.05]$, measuring $[x^2(1,N=472)=5.78, p>.05]$, testing samples with scientific instruments $[x^2(1,N=472)=0.00, p>0.05]$, and experimenting $[x^2(1,N=472)=0.81, p>0.05]$. More boys drew an astronomical scientist walking in space (see Figure 5) $[x^2(1,N=472)=38.41, p>0.01]$, working cooperatively $[x^2(1,N=472)=8.33, p>0.05]$, and collecting data $[x^2(1,N=472)=19.09, p>0.01]$ than girls. Significantly, more girls (16.59%) than boys (9.28%) perceived the nature of scientific work in astronomy as reporting $[x^2(1,N=472)=5.60, p<0.05]$ (see Figure 7).

Figure 7. A sample drawing showing two astronomical scientists working cooperatively (scientists observing and collecting data) drawn by a seventh grade girl

Excerpts from writings on their drawings and interview answers of the subjects to the question on the activities conducted by an astronomical scientist are as follows: “They do stuff like taking soil and stone samples from space,” “…looking at telescope,” “…looking at sky objects,” “…collect information about universe, stars, and sky objects,” “…looking for some samples obtained from space surface with a microscope,” (see Figure 8), etc.

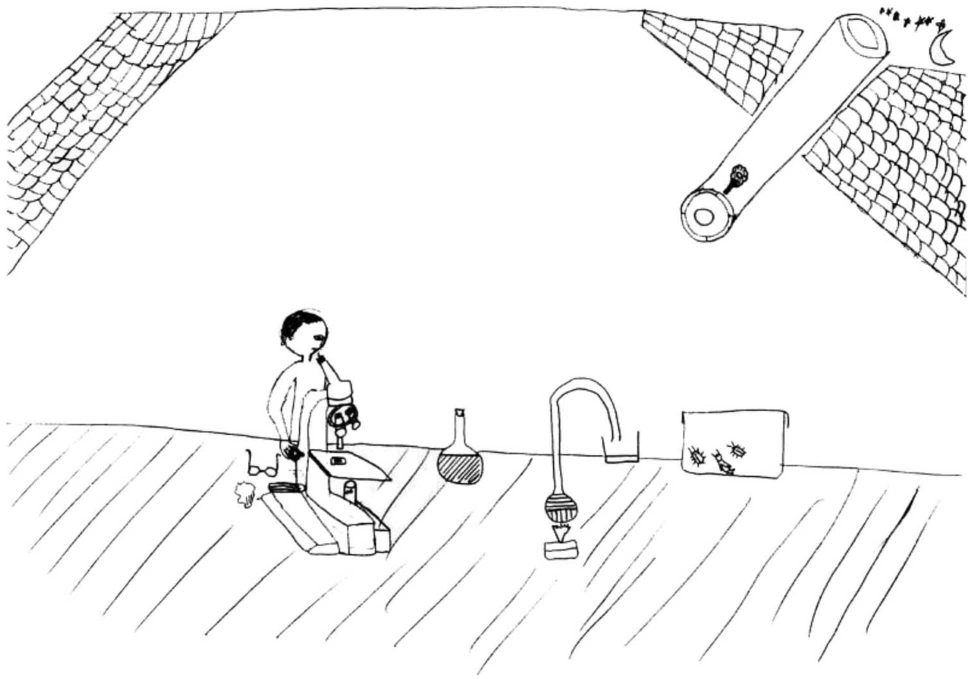

Figure 8. A sample drawing showing an astronomical scientist looking for some samples with a microscope drawn by an eighth grade boy

4. IMPLICATIONS

The results of this preliminary study show significant gender differences in images of a scientist who studies astronomy for primary school students in terms of some indicators. For more than two decades, we have been aware of the gender differences with regard to images of science, scientists, and science-related experiences. The primary school years are a time when gender differences in achievement and attitudes typically widen. When young girls and boys entering puberty lack the same science experiences and begin to encounter their peer's stereotypic beliefs about areas of study, the potential for the gender gap to widen is enormous. This study has implications for educators to see what barriers and opportunities are in the astronomy in gender context.

Although, in this study, the participants in both gender groups have been educated through the same curricula, the results of this study show that they hold different images of scientists who do astronomy in terms of some aspects. The reason for this different result may be interpreted as providing unequal opportunities for gender groups in schools or outside of school.

Knowing students' images by gender is important to build an effective learning and teaching environment in science and astronomy education for all. Teachers at the primary school level play a vital role in creating students' images of science and scientists. In this context, the results of this study provide useful information to those engaged in primary school science education. A clearer understanding of primary school students' images of scientists has implications for the science teachers of primary school students. Once teachers know what images of scientists who do astronomy may posses by gender, teachers can modify their teaching, perhaps by including visitors who represent astronomy related occupations, organizing field trips to see "astronomy in action," involving more equal hands-on astronomy activities in terms of gender, and bringing more science books and stories about female scientists in astronomy to the classroom. These experiences should provide exposure to a variety of role models, including female scientists, scientists from different cultures, and scientists conducting research in both field and laboratory settings.

In addition, the implications of this study are clear for textbook publishers and TV programers. As indicated by Sjoberg (1993) the textbooks, mass media such as magazines, newspapers, and televisions, especially TV, play an important role in the formation of students' images of scientists the students at primary school level textbooks influence students' images of science and scientists. Publishers and TV programers must take care to promote gender-neutral and positive images of science and scientists represented in their publications and programs (Siverton 1993).

In programs for primary students, video tapes or CDs featuring scientific expeditions and investigations present scientists in a real-life situation. Inviting women who study astronomy to talk with the class about how they learn and use astronomy would offer prospects for students to broaden their ideas about scientists who do astronomy on a more personal level. Building on these experiences, pointing out the scientific contributions made by females would further broaden students' perspectives. Historical sequences developing our understanding about the way things work would help students gain an appreciation of the contributions and personalities of scientists as "real people" (Barman 1997).

This study also has implications for the schools and the community. It has been shown that not all students have the same educational experiences. Schools and communities must provide equal opportunities for all students without regard to gender such as the effective schooling, extra educational help, and support systems they need to meet the educational standards demanded by the society. Teachers and schools should also recognize that students come to school with diverse backgrounds and provide constructive educational experiences, including science-related experiences, which build on those backgrounds.

The present study showed that the DAST is still a useful tool for exploring students' perceptions of scientists by providing symbolic indications of students' basic beliefs. However, the test does not allow one to derive any conclusions about the reasons underlying features in the pictures—only speculation is possible. It would be useful to adopt the recommendation of Boylan *et al.* (1992) to include interviews after the drawing activity to help the researcher to gain a greater insight into students' perceptions. In fact, the finding that some students added comments and captions on their drawings probably revealed that they found it difficult to express their views simply through drawing. Though work on students' images and/or perceptions of scientists and science have been reported periodically in the literature, this kind of study has never played as significant a role in science education as it could. Particularly in Turkey, where this appears to be the first reported study in this context, it would be worthwhile to conduct more extensive research in this area for a better understanding of our students.

The researchers who are interested in astronomy education can plan to continue to develop the Draw an Astronomical Scientist test by gathering additional data through one-on-one interviews with students about their responses to the test. Additionally, they can develop questions to allow students to demonstrate additional knowledge about scientists who do astronomy which the current instrument may not gather, such as the broad nature of the field of astronomy.

There are, of course, limitations to this study. The assertions made cannot be generalized from this small sample to all Turkish primary students. The assertions generated can provide an indication only of the images of science and scientists related to astronomy held by the wider population of primary school students.

In conclusion, this study extends the literature on students' images of astronomical scientists. The general impression gained is that there is a need for improvement in students' images of astronomical scientists. In today's scientifically and technologically expanding space age, it is important for teachers and other educators to be aware of students' existing images of astronomical scientists and to provide appropriate avenues for change.

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