

Primary School Students' Images of Scientists and the Sources of These Images

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Abstract

The aim of this study is to determine the 4th-grade students' images of the scientists and the relations between these images and the images of scientists that primary school teachers describe in their classes and the images presented in the 4th-grade textbooks. The sample of the study consisted of 244 4th-grade students, 10 teachers, and 4th grade science and social studies textbooks. The study was designed according to the case study design, which is one of the qualitative research designs. As a result of the study, it has been determined that the students have stereotypical images about gender, age, working environment, and the works of the scientists. While it was determined that 85% of the students draw male scientists. However, contrary to the results commonly seen in the literature, the image of a scientist with a lab coat is found to be at a lower level in this study. In addition, the results obtained in the interviews with the teachers and textbooks examined revealed that there are similarities between these images that the students have and the images that the teachers have taught and the images presented in the textbooks.

Keywords: Images of Scientist, Primary School Students, DAST, Primary School Teacher, Textbooks

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INTRODUCTION

The main aim of science education is accepted as having scientifically literate individuals (AAAS,1993; NRC, 1996). In a world full of scientific research products in the 21st century, scientific literacy is a need for every individual (Bybee, 1995; Hurd, 1998). For this purpose, the Science and Technology lesson curriculum, which changed with the reform of the primary education curriculum in our country in 2005, by the Ministry of National Education (MONE), adopted the vision of "educating all students as science and technology literate" unlike the previous programs (MEB, 2005; 2013; 2018). Scientific literacy requires having a realistic understanding of how the scientific process works and who the scientists, who are an important subject of this process, what characteristics they have, and how they continue their studies. (Brown, Grimbeek, Parkinson, and Swindell, 2004; Hurd, 1998; McComas, 2017). Students' understanding of science and scientists will have important long-term effects for both individuals and society (Schibeci, 2006; Newton & Newton, 1998). For this reason, examining images of scientists among students together with these images presented in lessons by their teachers and presented in textbooks, which are the two important components of school life and which are the source of these images, will guide the education process in having scientific literate individuals.

One of the earlier research about students' images of scientists was conducted by Mead and Metraux (1957). The result of this study is that scientists are mostly male, working in the laboratory, a with white coat, glasses, old, tired, in a laboratory full of test tubes and bottles, and shouting "I found, I found". There has been much research on the images of students about scientists after this study (Akçay, 2011; Chiang and Guo, 1996; Lee and Kwon, 2019; Newton and Newton, 1992, 1998; Tuckey, 1992). The results of these studies also revealed that students mostly have stereotyped images of scientists (Blagdanic, Kadijevic, and Kovacevic, 2019; Finson, 2002; Miller, Nolla, Eagly, and Uttal, 2018; Schibeci, 2006). Research on images of scientists and science among students have been done mostly in the USA and Europe. Toğrol's (2000) study is one of the earlier research on the images of Turkish students about scientists. After this study, many studies were carried out on different samples (Baday, 2019; Baybars, 2018; Buldu, 2006; Çakıcı, 2018; Çermik, 2013; Demirbaş, 2009; Küçük ve Bağ 2016; Özdeş ve Aslan, 2019; Özgelen, 2012; Toğrol, 2013; Türkmen, 2008). Türkmen (2008), in his study, determined that the source of students' understandings about scientists is mostly teachers. Similarly, Çakıcı (2018), in his study stated that while there was diversity regarding the images kindergarten and elementary school students have, the perceptions of middle school students were stereotyped.

It is stated that television, books, curriculum, textbooks, and teachers are generally effective in forming the images of children about scientists (Ağgül-Yalçın, 2012; Baday, 2019; Çakıcı, 2018; Driver, Leach, and Millar, 1996; Newton and Newton, 1998; Özgelen, 2012; Türkmen, 2008). However, among all these factors, the effects of teachers and textbooks with whom they interact very intensely in the development of the image of the scientist of students stand out one step further than others (Baday, 2019; Türkmen, 2008). She (1995) states that textbooks are effective at a certain level in the formation of scientist images of children. Another study stated that stereotypes about scientists are lower among students in lower grades compared to other upper ones (Narayan, Park, Peker, and Suh, 2013).

Although it is stated in these studies that students have are stereotypical images about a scientist and that textbooks play an active role in these images, there is a few studies that have been conducted on examining the textbooks. Images about scientists among students and the effects of their teachers and textbooks, which are two important components of school life, in the formation of these images, should be better understood. However, in the studies conducted so far, it has been determined that the scientist images of the students are mostly handled independently from the source of these images. In this study; unlike previous studies, it was aimed to reveal the associations between the images of scientists the students have and the images the teachers taught, and the images in the textbooks. The following questions were investigated in the study:

1. What are 4th-grade students' images about scientists?
2. What similarities or differences are there between the images 4th-grade students have and the images that teachers tell about scientists in their lessons?
3. What similarities or differences are there between the images primary school 4th-grade students have and the images in the textbooks about scientists?

METHOD

The study was planned according to the case study design, which is one of the qualitative research designs. In a case study detailed data is collected about a current limited situation in real life or multiple situations in a certain time period through multiple information sources such as audio-visual materials, documents, interviews, or reports (Creswell, 2013). The case study design was used as it was aimed to reveal the connections between the scientist images of the students and the scientist images taught in schools and the images included in the textbooks.

Sample

The sample of the study involved 244 4th grade students (9-10 years old) studying in the city center of Gümüşhane in the 2017-2018 academic year, 10 classroom teachers of these students, and science and social studies textbooks. The participants of the study were determined according to the convenient sampling method. Due to the limitations in terms of labor, money, and time the sample consists of easily accessible and practicable units this method was used (Büyüköztürk, Çakmak, Akgün, Karadeniz & Demirel, 2016).

Data Collection

Data were collected in three phases. In the first phase, the students were asked to draw a scientist using Draw A Scientist Test (DAST), developed by Chambers (1983), and to explain their drawings briefly in writing in order to prevent them from being understood differently from what they were trying to explain. In the second phase of the study, the images about scientists in the fourth-grade science (Kaya, 2017) and social studies (Evirgen et al., 2017) textbooks were examined. In the last phase of the study, a semi-structured interview was managed with the teachers to examine whether there is any connection between the scientist images of the students and the images taught. Questions about scientists and how they teach about scientists were asked to the teachers.

Data Analysis

To analyze students' drawings, a checklist for DAST-C developed by Finson et al. (1995), was used. The drawings of the students who did not completed them at the end of the application were excluded from the analysis. In order to increase the consistency of the analysis, the students were asked to explain the pictures they drew in order not to make wrong interpretations about the scientist they drew. In order to ensure the reliability of the data analysis, the data of 35 random students were re-examined. The reliability of the analysis is $\alpha=, 93$.

RESULTS

As results in Table 1. it is seen that the students mostly draw scientists with glasses with a ratio of 21% regarding the external appearance of the scientist. It was determined that 12% of the students drew scientists wearing lab coats, while 15% drew scientists with complex facial hair, beard, and mustache. While it was determined that 85% of the students draw a male scientist, 13% a female scientist, and it was found that only one student draw a female scientist and a male scientist working together. Examples of these kinds of drawings are presented in Figure 1. and 2.

Table 1. Appearance and gender of the scientists

	f	%
Glasses	49	21
Facial Feathers	36	15
Lab Coat	28	12
Male	200	85
Female	31	13
Male and Female	1	.4
N=236		

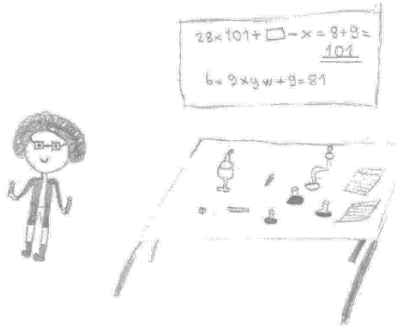


Figure 1. A Drawing depicting a scientist wearing a lab coat and glasses (S57)



Figure 2. A Drawing depicting a scientist with facial feathers (S62)

Sample drawings of the students regarding the gender of the scientist are in the following. In Figure 3, the student stated that he drew Einstein. In Figure 4, one of the students drew a picture of a female scientist. In Figure 5, a student drew a male and a female scientist working together.



Figure 3. A Drawing Depicting a Typical Male Scientist (S59)

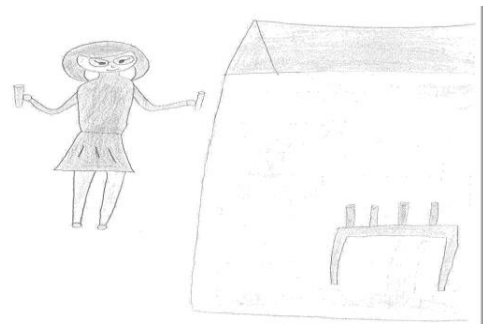


Figure 4. A Drawing Depicting a Female Scientist (S96)

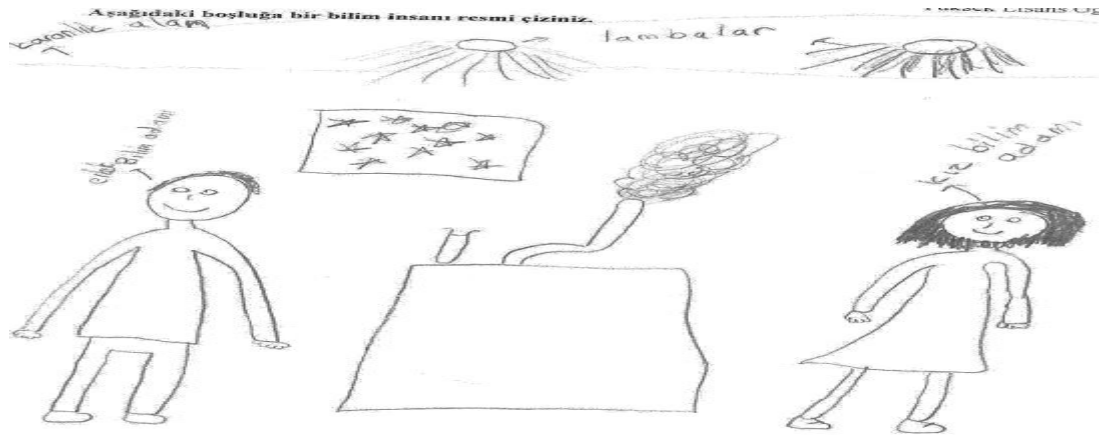


Figure 5. Drawing of a Male and Female Scientist Working Together (S72)

Table 2. Use of research, information, technology, text expressions, danger, and confidentiality statements:

	f	%
Research Symbols	133	56
Information Symbols	58	25
Technological tools	107	45
Text Expressions	26	11
Danger Statements	4	2
Confidentiality Statements	0	0
N	236	

According to results in Table 2, 56% of the students depicted the scientists using laboratory materials such as test *tubes*, microscopes in their drawings. The drawing of a student depicting a scientist in the working environment is given in Figure 6. 25% of the students draw a scientist with information symbols such as a book and a pen. One of these drawings is given in Figure 7.

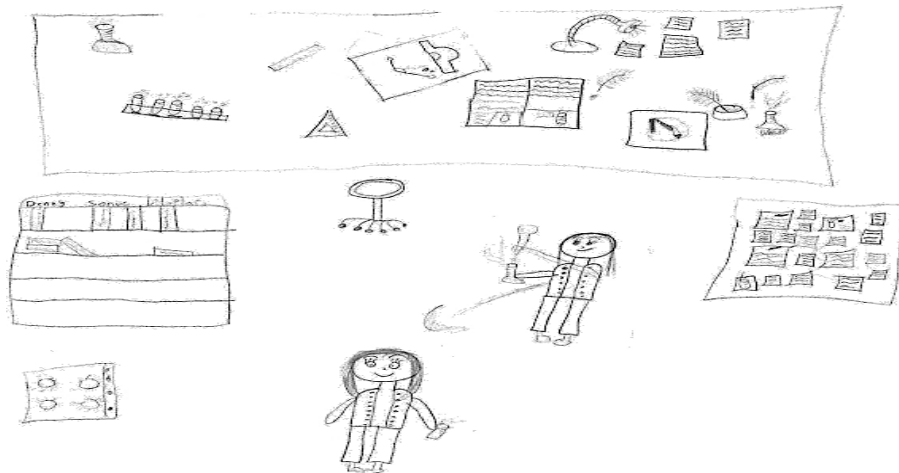


Figure 6. A Drawing Depicting a Scientist with Research Symbols (S86)

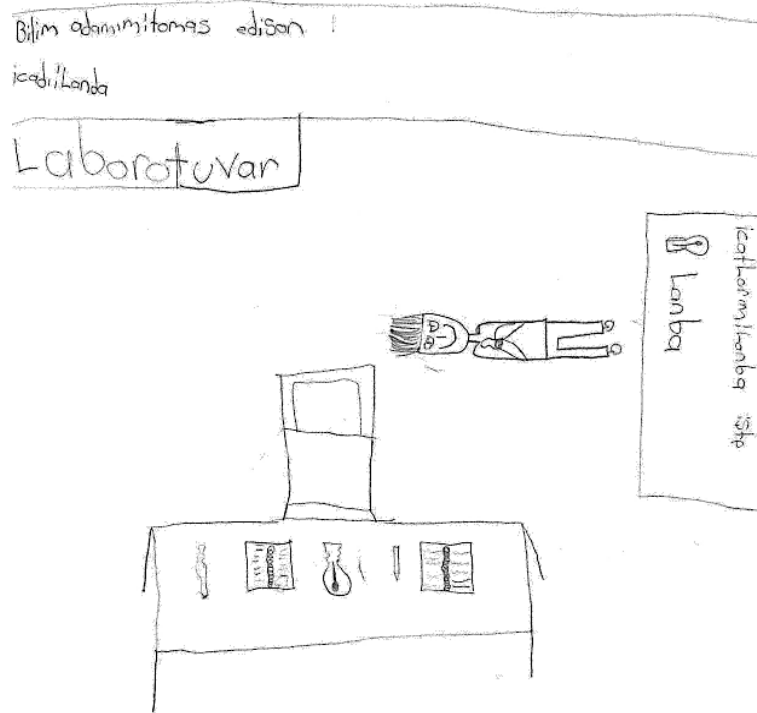


Figure 7. A Drawing Depicting Information Symbols Used (S136)

It is seen that 45% of the students draw the scientist in their work environment with technological devices. The drawing of a *student* showing the scientist with technological tools is given in Figure 8. It was determined that 11% of the students included formulas, taxonomic classifications, expressions such as "I found it" in their drawings. A drawing of one of the students who included text and expressions in his drawing is given in Figure 9. In addition to Table 2, while 2% of the students included danger statements in their drawings, no confidentiality statements were found in their drawings. However, while two of the students did not include any element related to privacy in their drawings, they stated that scientists work in secret rooms in their explanations. A drawing of one of the students who mentioned danger statements is given in Figure 10.



Figure 8. A Drawing Depicting Scientist with Technological Tools (S81)

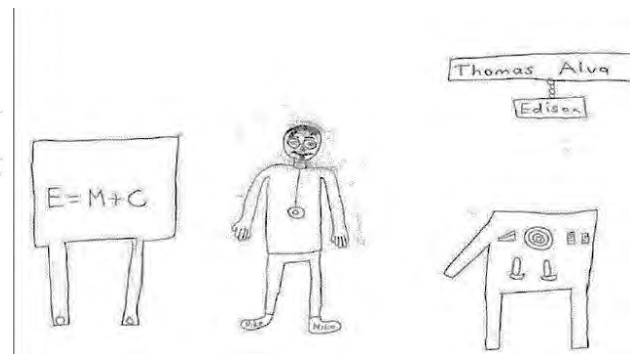


Figure 9. A Drawing Depicting a Scientist Who Writes Formulas (S59)

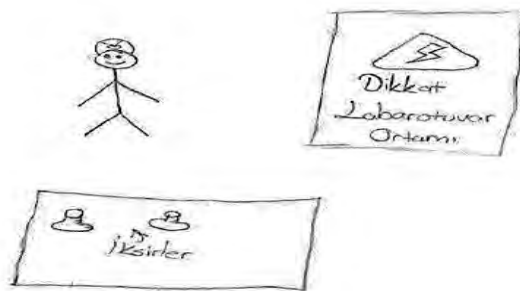


Figure 10. A Drawing Depicting Hazard Statements Used (S92)

When the answers given by the students were examined, it was found that the scientists drawn by 41% of students were *between* the ages of 25-50. While 28% of the students stated that the scientist they drew was in the 50-90 age range, 16% in the 0-25 age range, 15%.

Table 3. Findings about the Age of the Scientist

	f	%
25-50	98	41
0-90	66	28
0-25	37	16
Invalid and Null Data	35	15
N	236	

It is seen that the students mostly (46%) drew scientists in the laboratory. In addition, 41% of the students stated that the scientist they drew worked in closed environments such as a company, home, study room, and a secret room, 2% in open environments such as gardens and fields, 1% in space, 1% in hospitals. *Sample drawings of students showing that the scientists work in different environments are given below:*

Table 4. Drawings about the Scientist's Working Environment

Working Environment	f	%
Lab	108	46
Indoor Environment	97	41
Open Environment	4	2
Space	2	1
Hospital	2	1
Unanswered	23	9
N	236	

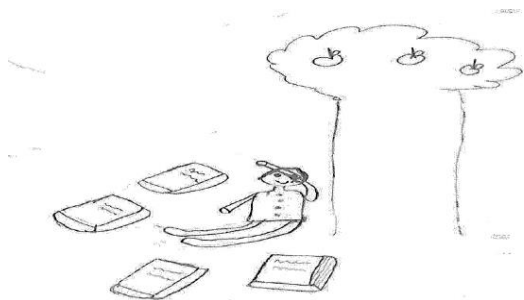


Figure 11. A Drawing Depicting a Scientist Working in an Open Environment (S46)



Figure 12. A Drawing Depicting a Scientist Working in the Laboratory (S58)

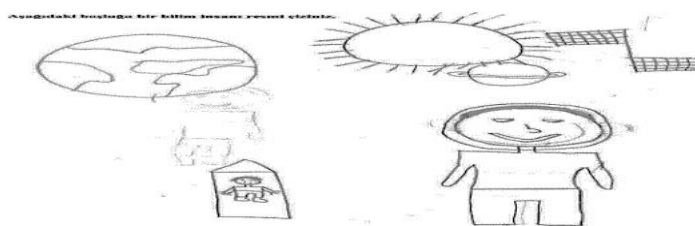


Figure 13. A Drawing Depicting a Scientist Working in the Space (S11)

The results regarding the answers given to the question are given in Table 6. 35% of the participants depicted familiar scientists in their drawings. 18 % of the students stated that they portray the scientist in their dream, and 5 % of them stated that the scientist in their dreams were their close friends such as his father and brother, etc. Table 6, it was found that the students mostly illustrated Thomas Edison with a ratio of 19%. Then respectively 6% Einstein, 3% Nicholas Conte, 2% Grahambel, 1% İbni Sina, 1% Al Cezeri, 1% drew Aziz Sancar.

Table 5. Answers to the "Who is the Person in Your Drawing?"

Who is the person in your drawing?	f	%
A Known Scientist	82	35
My Dream Scientist	43	18
A Person in a closed environment	12	5
Unanswered	99	42
N	236	

Table 6. Drawing Rate of Known Scientists

Widely Known Scientists	f	%
Edison	46	19
Einstein	14	6
Nicholas Conte	7	3
Grahambel	4	2
El Cezeri	3	1
İbni Sina	2	1
Aziz Sancar	2	1
Newton	1	.5
Hezarfen Ahmet Çelebi	1	.5
Mimar Sinan	1	.5
Elon Musk	1	.5
N	236	

When the answers given by the students were examined, it was determined that the students stated that they gained information about the scientists mostly from their teachers with a rate of 21%. In addition, 17% of them stated that they learned this kind of knowledge from the book.

Table 7. "Where Did You See the Scientist You Draw or Whom Did You Learn From?"

	f	%
From my teacher	50	21
From the book	41	17
From TV	32	13
My dream	19	8
My close environment	15	6
From the Internet	9	4
Unanswered	70	30
N	236	

It was determined that the students stated that scientists invented technological devices such as cars, machines, robots, invented light bulbs and the scientist was engaged in experiments. In addition, the students stated that the scientist invented the pen, dealt with a rocket, studied with a microscope, prepared formulas such as immortality and invisibility.

Table 8. Scientist's Work

Scientist's interest	f	%
Making invent	58	24
Invented the light bulb	49	21
Experimenting	47	20
Preparing potions	11	5
Invented the pen	6	2
Invented the phone	5	2
Dealing with rocket	6	2
Writes formulas	2	1
Examining with a microscope	3	1
Working in the field	1	.5
Mosques built buildings	1	.5
Works in hospital	1	.5
Shattered the atom	1	.5
Unanswered	45	19
N	236	

In order to determine the way scientists are included in the textbooks, primary school 4th grade Science books were provided to schools by the MONE in the 2017-2018 academic year. As a result of the examination, it was found that there are only two mentions about scientists only in the third science textbook. (Edison-Lewis Latimer). However, no mentions were found regarding the personal characteristics and life stories of these scientists. The information about the scientists given in the analyzed social studies textbooks is presented in the following

Table 9. The Information about the Scientists Mentioned in the Social Studies Textbooks

Scientists	Physical appearance	Invention and design	Scientist characteristics
Johan Gutenberg		X	
El Cezeri	X	X	
Edison	X	X	
Humphry Davy		X	
Carl Friedrich Benz	X	X	
Nicolas Conte	X	X	
Leonardo da Vinci		X	
Joseph and Etienne Montgolfier		X	
Wilbur and Orville Wright		X	
Yuri Alekseyevich Gagarin	X	X	
Lagari Hasan Çelebi		X	
Ferdinand von Zeppelin		X	
Igor Sikorsky	X		
Abbas İbn Firnas			
Hezarfen Ahmet Çelebi			
Vecihi Hürkuş			
Nuri Demirağ			
Steven Paul Jobs	X		X
Albert Einstein	X		X
Prof. Dr. Fuat Sezgin	X		X
Charles Tripp and Eli Bovven	X	X	
Josephine Cochrane		X	

It is emphasized that Johann Gutenberg is the pioneer of the printing house in the social studies textbook and his name and invention are included in the book (Figure 14). For the invention of

technological devices, the inventions of scientists such as El Cezeri, Thomas Alva Edison, Carl Friedrich, Nicholas Conte were included along with their pictures. An example excerpt from the book is presented in Figure 15.



4.8

Alman Johann Gutenberg (Yuhan Gutinbörg) tarafından tasarlanmış matbaanın öncüsü olan ilk baskı makinası

Figure 14. Picture of First Printing Machine P.89



Nicolas Conte (Nikilıs Kantey)

1794'te kurşun kalemın bildiğimiz şeklini oluşturdu. Tahtadan silindir çubuklar içine grafit ve toprağı karıştırarak yerleştirdi. Kurşun kalemi icat etti.

4.16



4.17

Figure 15. The Figure of Nicholas Conte, p.90

On page 91 of the social studies textbook, an infographic on the development of machine tools over time is given. In addition on page 91, a research assignment was given to the students for the roles of Abbas Ibn Firnas, Hezarfen Ahmet Çelebi, Vecihi Hürkuş, and Nuri Demirağ in this process. Under the text titled "Wonder of Design" on page 97, along with the statement, "Imagination and wonder are the basis of the invention" the related sayings of the inventors are included. The related part of the textbook is shown in Figure 16. And only one female scientist among all these scientists is included in the social studies textbook.



4.39

Albert Einstein (Albirt Aynstayn)

(1879-1955)
"Benim hiçbir özel kabiliyetim yok ben sadece çok meraklıyım."



Prof. Dr. Fuat Sezgin'in gayretleri ile kurulan
İstanbul İslam Bilim ve Teknoloji Tarihi Müzesi
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4.41

Steven Paul Jobs (Sittivin Pol Cabs)

(1955-2011)

"Hayatım hayallerimi kovalamakla geçti. Bir şey yaptığınızda iyi sonuç alırsanız, bir başka şey daha yapın ve ona çok uzun süre takılıp kalmayın. Bir sonrakinin ne olacağını düşünün."



4.40

Prof. Dr. Fuat Sezgin (1924-....)

"Hocam bana bir gün sordu, kaç saat çalışıyorsunuz? Ben, günde 13-14 saat çalışıyorum dedim. 'Ne, dedi. Bu tempoyla bir bilim adamı olamazsın. Eğer bilim adamı olmak istiyorsanız bunu çok daha arttırmalısınız' dedi. O, günde 24 saat çalışırdı. Günler uzun olsaydı daha çok çalışacaktı."

Figure 16. Sayings of Inventors P.97

It was found that the students mostly draw the scientist with glasses (21%) and 12% of the students drew a scientist wearing a lab coat, while 15% of them drew a scientist with complex facial hair, such as a beard and mustache. Similarly, in the social studies book, there are scientists with glasses in, a scientist in a lab coat, and a scientist with facial hair. Regarding the use of technological devices, it has been observed that in a large part of the unit, science is associated with the invention of technological tools. There is no clear information about danger, confidentiality statements, and working environments in the textbook. *It is seen that most of the scientists included in the students' drawings are also included in the textbook. In addition, it was seen that the book included a visual of a*

scientist, as is shown in Figure 17, drawn by students and possessing stereotypes frequently encountered in the media.



Figure 17. A Scientist Image in the Textbook on P.105

Teachers stated that information about scientists is given in the "Lighting and Sound Technologies from Past to Present" unit in the science lesson and in the "Science, Technology and Society" unit in the social studies lesson. Teachers stated that they emphasized that scientists generally conduct experiments tirelessly, are influenced by each other, and make inventions for the needs of people and they give information about scientists' discoveries rather than their external appearance, personal and social aspects in their lessons. It was also stated by teachers that the students asked their teachers in the lessons questions about how scientists are intelligent, why they work hard, how they perform their experiments, and whether it is easy or difficult to be a scientist. Several of the teachers used the term male scientist during the interview. In addition, a teacher stated that, in general, teachers do not have sufficient knowledge about scientists.

CONCLUSION, DISCUSSION, AND RECOMMENDATIONS

As a result of this study, It was determined that scientists took place in the student drawings with the highest rate (21%) as people with glasses according to their external appearance. However, in the literature (Blagdanic, Kadijevic, and Kovacevic, 2019; Çakıcı, 2018; Doğan, 2015; Kathryn et al., 2016; Kaya et al. 2008; Mead & Metraux, 1957; Ruiz-Mallén and Escalas, 2012); Toğrol, 2000; Toğrol, 2013), it was found that the common image of a scientist in a lab coat is at a lower level (12%) in this study. 56% of the students drew the scientist as people working with research symbols and 45% as people working with technological tools. These high rates are in line with other studies in the literature (Camcı-Erdoğan, 2013; Emvalotis & Koutsianou, 2017; Türkmen, 2008; Yalçın, 2012). It was determined that the use of danger and confidentiality expressions in students' drawings has a very low percentage.

When the images of the scientist's working environment are examined; while 46% of the students stated that scientists work in the laboratory. Based on these results, according to the literature about the scientists working in the laboratory (Blagdanic, Kadijevic, and Kovacevic, 2019; Gheith and Aljaberi, 2019; Kaya, Doğan and Öcal, 2008; Korkmaz, Hünkar; Kavak, 2010; Toğrol, 2000), we can say that it still has stereotyped images. It is seen that the students are unaware of the examples of many scientists who worked for a long time in the monastery garden like Mendel, on the farm like Newton, and on a research ship like Darwin (Doğan et al., 2009). One of the important findings determined in this study is that the delusion of perceiving the scientist as a male, which has been dominant for the last 15-20 years, still continues (Buldu, 2006; Demirbaş, 2009; Gheith and Aljaberi, 2019; Nuhoglu & Afacan, 2011; Oğuz- Ünver, 2010; Toğrol, 2000). In this study, some students even answered the question about the gender of the scientist as "of course male". In addition, it was determined that most of the students used the concept of "male scientist". One of the interesting findings obtained is that only one student portrayed a male and female scientist working together.

Regarding, the connections between the images that students have and the images in the 4th-grade science and social studies textbooks, it was seen that only Thomas Alva Edison's invention of

the light bulb was mentioned in the science book. It has been seen that there is no information about the characteristics or life stories of scientists. In the social studies textbook, the discoveries of 22 different scientists and the sayings of a few scientists are included. In addition, it was seen that only one female scientist in the social studies textbook. In this study, it was determined that 85% of the students drew a male scientist, while 13% drew a female scientist, and it was found that only one student painted a female scientist and a male scientist working together. This result shows that there are similarities between students' images of scientists and scientists towards gender in textbooks. In addition, a visual of a scientist drawn by students in the social studies textbook and having stereotypes that are frequently encountered in the media was found (p.105) in the textbook. The similarity between this visual and the scientist images students have indicates that the textbook has an important role in creating the image of a scientist in students' minds. The students generally stated that the scientist they drew invented technological tools and made experiments, and it was observed that the majority of the students stated that the scientist made the invention by being influenced by the invention of Nicholas Conte's pencil, Thomas Alva Edison's invention of the light bulb and the discoveries of other scientists. This result may be due to the fact that only the discoveries of scientists are included in the primary school 4th-grade textbooks. According to the results obtained in this study, it is seen that the stereotypical images still continue in parallel with other studies such as the scientist's making experiments and inventions, drawing in middle age, with glasses, and as a man, working in closed environments such as laboratories.

If we compare to other studies, it can be said that the stereotypical images of the scientist as a lab coat, bald person with facial hair, and the use of danger and confidentiality expressions in the work environment have decreased. In addition, interviews were made with teachers to determine the source of the images students have. In the literature, the teacher; It is widely believed that is one of the important factors in the formation of scientist images of students (Baday, 2019; Balkı, Çoban, & Aktaş, 2003; Buldu, 2006; Çakıcı, 2018; Türkmen, 2008). A teacher cannot be expected to explain a concept or subject that he or she is not familiar with. Or the teacher teaches as she/he knows (Akçay, 2014). In this study, the responses of students to “Who is the person you are drawing? From whom did you learn about this person?” showed that the teacher played an important role in the formation of the scientist's image. Also, the fact that the students portray the scientist as the inventor of technological tools and the teachers stated that they generally talked about the discoveries of the scientists in their lessons shows that the students were impressed by their teachers in this respect as well.

Science fairs can be organized where students can come together with scientists in order to eliminate the stereotypical scientist perception of students and to show that science can be done in different settings and ages. Scientist figures used in resources affecting students' image of scientists should be arranged in a way that students develop positive images towards the scientist. As a country that aims to raise scientifically literate individuals; it is thought that it is very important to explain the importance of science history in terms of science teaching without neglecting it.

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