(Araştırma Makalesi / Research Article)

Kastamonu Eğitim Dergisi
Kastamonu Education Journal
Mart 2020 Cilt:28 Sayı:2
kefdergi.kastamonu.edu.tr

Başvuru Tarihi/Received: 29.10.2019
Kabul Tarihi/Accepted: 30.11.2019
DOI: 10.24106/kefdergi.702955

Examining the Profiles of Scientists in Secondary Science Textbooks in Turkey
Türkiye'deki Ortaöğretim Fen Bilimleri Ders Kitaplarında Yer Alan Bilim İnsanı Profillerinin İncelenmesi

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Abstract

The aim of this study is to examine the profiles of scientists in textbooks prepared to be taught in high school science courses in Turkey. The sample of this study consists of 33 high school science textbooks prepared by the Ministry of National Education Publishing House for both general high schools and science high schools and by private publishing houses for the textbooks of biology, physics and chemistry courses at high schools in 2018-2019 academic year. Document analysis design, which is one of the qualitative research methods is used in this study. The data of the study are analyzed in terms of gender, nationalities, physical characteristics, the types of scientific study and working environments of the scientists in the textbooks according to class level, science field and the type of publishing house. According to the results of the study, there is no balanced distribution of gender and nationality in textbooks. In addition, it has been found that scientists are represented as stereotypes and the working environments and forms are largely ambiguous. The results of this study indicate that the descriptions of scientists made in secondary school science textbooks should be rearranged in Turkey.

Keywords: Science textbooks, scientists, document analysis

Öz

Bu çalışmanın amacı, Türkiye'de ortaöğretim düzeyinde fen bilimleri derslerinde okutulmak üzere hazırlanmış olan ders kitaplarındaki bilim insanı portrelerinin incelenmesidir. Bu amaç doğrultusunda 2018-2019 döneminde Milli Eğitim Bakanlığı (MEB) Yayınevi'nin liseler, MEB Yayınevi'nin fen liseleri ve özel yayınevlerinin liselere yönelik biyoloji, fizik ve kimya derslerinde okutulmak üzere hazırladıkları toplam 33 ortaöğretim fen bilimleri ders kitabı çalışmanın örneklemini oluşturmuştur. Bu çalışma nitel araştırma desenlerinden doküman incelemesini içermektedir. Çalışmanın verileri, ders kitaplarındaki bilim insanlarının cinsiyetleri, milliyetleri, fiziksel özellikleri, bilimsel çalışma şekilleri ve çalışma ortamları bakımından sınıf düzeyi, fen bilimleri alanı ve yayın evi türüne göre analiz edilmiştir. Çalışmanın sonuçlarına göre, ders kitaplarında bilim insanlarının cinsiyet ve milliyet olarak eşit dağılmadığı bulunmuştur. Buna ek olarak, bilim insanlarının basmakalıp olarak temsil edildiği ve çalışma çevreleri ile şekillerinin ise belirsiz olduğu bulunmuştur. Bu çalışmanın sonuçları, Türkiye'deki ortaöğretim fen bilimleri ders kitaplarında sunulan bilim insanı tasvirlerinin yeniden düzenlenmesi gerektiğini göstermektedir.

Anahtar Kelimeler: Fen bilimleri ders kitapları, bilim insanları, doküman incelemesi

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Atıf / Citation: Goksu, V. & Inaltekin, T. (2020). Examining the profiles of scientists in secondary science textbooks in Turkey. *Kastamonu Education Journal, 28*(2), 965-979. doi:10.24106/kefdergi.702955

Extended Abstract

Introduction: *The content and representations regarding the history of science in science education enable students to define science as a human occupation, not as a dull and uncertain collection of information (Idin & Yalaki, 2016). In science education, the most practical way of scientists' making the scientific research processes more apparent for students is to be able to project them upon textbooks (Yacoubian, Al-Khatib, & Mardirossian, 2017). However, it is pointed out that the scientists presented in the textbooks of science are often described as western, male and with glasses, white coat and isolated and ambiguous way of working as if they were from a single mold (Karaçam, Aydin, & Digilli, 2014; Yacoubian et al., 2017). It is pointed out that this kind of description particularly cloaks the understanding of scientists in students in a guise of a stereotypical image to a large extent (Christidou, Hatzinikita, & Samaras, 2012; Samaras, Bonoti, & Chistidou, 2012; Villar & Guppy, 2015).*

Aim: *When the effect of the scientists in science textbooks on configuration of students' science image are taken into consideration, the examination of how scientists are presented in science textbooks in Turkey has shown up as a need. The present study conducted from this viewpoint aims to investigate the profiles of scientists in textbooks prepared to teach in science lessons of secondary education institutions in 2018-2019 academic year in Turkey.*

Method: *In this study, document analysis which is one of the qualitative research methods was used. Although totally 36 books should have been reviewed for four grade levels (9-12) of secondary education, a ninth grade biology textbook belonging to Publishing House of Ministry of National Education, an eleventh grade chemistry textbook belonging to a private publishing house and a twelfth grade biology textbook belonging to a private publishing house were unattained. In this context, the sample of the study consisted of a total of 33 textbooks being taught in science lessons of secondary education institutions. The study data were analyzed in five contexts as gender, nationality, physical properties, working manners and working environments of scientists in terms of class level, type of publisher and scientific area.*

Findings: *The first finding of the study revealed the scarcity of female scientists in the distribution of gender in secondary school textbooks. At the same time, it was determined that the distribution of scientists by gender did not show a systematic and normal distribution at all grade levels. The second finding revealed the scarcity of indigenous scientists in the distribution of scientists in secondary school textbooks by their nationalities. It was also found that the distribution of scientists by their nationalities is not systematic and normal at all grade levels. The third finding showed that secondary school textbooks present a stereotypical understanding of scientist according to the physical properties of scientists. The fourth finding showed that textbooks are weak in terms of depicturing the field and scientific research systematics of scientists according to their way of work. The last finding of the study is that secondary school textbooks are highly weak in terms of realistically depicturing the work environments of scientists.*

Discussion and Result: *It has been determined that the image of male scientist is more prominent than that of female scientist in the distribution of scientists according to gender. In the literature, the negativity of prominence of male scientist image predominantly in the course materials is particularly associated with the decrease in the interest of female students in science. It is also revealed that such an image of a dominant male scientist makes female students think that the scientist must be male (Charles & Grusky 2004; Unver, 2010; Yacoubian et al., 2017). It was seen that the distribution of scientists in science textbooks by nationality was mostly foreign (Western / European), whereas the number of Non-Western scientists remained quite low. It can be said that textbooks, predominantly visualized with western scientists, will instill an understanding supposing that science began and has continued with Europe to the students as a fact to be accepted. Thus, it is clear that this stereotyped understanding of western scientist in science textbooks in secondary schools in Turkey needs to be balanced with Non-Western scientists from other civilizations. According to the physical properties of scientists in textbooks, it is seen that they have taken part with the image of stereotyped scientists. It can be concluded that this situation does not particularly reflect today's understanding of contemporary scientists and will prompt students to approach this stereotypical understanding of scientists negatively. It has been determined that the vast majority of scientists are portrayed indefinitely with respect to ways of work. This result of the research can be associated with the effect of students on the ways of understanding the nature of science (Abd-El-Khalick, Waters & Le, 2008; Ramnarain & Chanetsa, 2016). Representations regarding actions of scientists in science textbooks enable students to form an opinion about the ways scientists research science. In addition to this, many scientific discoveries from past to present have emerged as the product of team work. Today, when the complexity and interdisciplinary relationship of the field of science are considered, it can be said that they reveal an understanding which requires scientists to work in teams. Thus, it is seen that work images of scientists in science textbooks in Turkey today are free from representing it. It has been found that the textbooks are weak in terms of showing the working environments of scientists in a real or realistic way. It can be said that depicting the working environments of scientists depending on field of science will make significant contributions to the students' developing their understanding of the nature of science. Scientists are often described as stereotyped individuals who work alone, wear gowns and glasses, are bald-headed and messy-haired, work in the laboratory, always try to discover something with mice, rabbits, chemicals and test tubes. When the results of this study are considered in its entirety, it can be said that the stereotyped image of scientists is intensely preferred in secondary school textbooks of science in Turkey in terms of class level, class field and types of publishers.*

1. Introduction

The importance of giving science history wide coverage in science education has been emphasized by many researchers (Clough, 2017; Conde & Salomon, 2018; Lehavi & Eylon, 2018; Pellegrino, Peters-Burton & Gallagher, 2018; Simon, 2015). Especially the content and representations related to the history of science in science education enable students to define science as a human endeavor, not as a collection of dull and ambiguous information (Idin & Yalaki, 2016). In addition, the history of science is seen as a means that can be used to educate students as science literate individuals (Lacin-Simsek, 2009). It is aimed that students have an idea about the processes in which scientists produce knowledge by utilizing the history of science in science (Koseoglu & Durukan, 2017). The most useful way to make scientific research processes more prominent for students in science education is to reflect them in textbooks (Yacoubian, Al-Khatib, & Mardirossian, 2017). Textbooks are one of the most basic means in order to store and transmit information and are the most important guiding light in understanding specific topics for students (Khine & Liu, 2017; Lee, 2010; Nakiboglu, 2009). The scientific content and formal quality of the textbooks have a significant impact on learning and teaching science (Khine, 2013). In particular, the fact that the scientific texts are effectively supported through visual learning representations is a key element in advancing science literacy and understanding knowledge (Tippett, 2016). Therefore, since it is not possible to observe the scientific processes of scientists in the past, it is important to make these situations understandable through visual representations in a course (Preston, 2017; Yacoubian et al., 2017). However, it is pointed out that the scientists presented in the science textbooks are often described as standard western, male, spectacled, with white coats, alone and having an unclear working style (Karacam et al., 2014; Yacoubian et al., 2017). When studies on this subject are examined, it is revealed that students thinks that scientists have a stereotypical image to a large extent (Archer et al. 2010; Christidou, Hatzinikita, & Samaras, 2012; Samaras, Bonoti, & Chistidou, 2012; Villar & Guppy, 2015). This stereotypical perception causes that for example scientist working in nature are described in a similar way by students, or it reveals that science is just done and can be done in Europe, indeed just in the west for students. It may not be surprising in Western nations, but it is a strange situation for Turkey, which is a part of Islamic civilization. The contribution of Non-Western civilization to science, which has quite a rich history of science, cannot draw due interest in our own textbooks (Idin & Yalaki, 2016). It can also give the impression to the students in Turkey and Non-Western countries that science is an effort made by just the Westerns. This may lead many students to think that their civilization makes no contribution to science. On the contrary, the famous Islamic science historian Fuat Sezgin's remark about the contribution of Non-Western civilization to science is striking (Turan, 2010):

The history of science is a common heritage of people. From 850 AD until the end of the 16th century, Muslims have constantly discovered new things in science. They established new sciences, developed old sciences, and laid the foundations for some future sciences. Today, I define the sciences in Europe as the continuation of Islamic sciences in another geography under different historical conditions (p.18).

These words mentioned above are an effort to show new writers a way to get out of the stereotypical scientist perception, which ignores the contribution of Non-Western civilization to science especially in textbooks for many years. DeWitt et al. (2013) states that how scientists are described can affect how children identify themselves with science. In particular, this image of a scientist in science textbooks is thought to have significant effects on students' perceptions of scientists (Erten, Kiray & Sen-Silver, 2013). The images of the scientists in science textbooks have been studied by many researchers (Koseoglu & Durukan, 2017; McDonald & Abd-El-Khalick, 2017; Vesterinen et al. 2013; Villar & Guppy, 2015; Yacoubian et al., 2017). Drakopoulou, Skordoulis and Halkia (2005) state that the main purpose of including science historical elements and scientists in science books is to provide students with a positive attitude and motivation towards science courses.

There are a limited number of studies upon examining portraits of scientists especially in secondary school science textbooks in our country. (Idin & Yalaki, 2016; Koseoglu & Durukan, 2017; Lacin-Simsek, 2009; Lacin-Simsek, 2011). High school science books are examined in terms of the history of science and philosophy (Kilic, 2010; Niaz & Costu; 2012; Yildiz, 2013). However, there is no study to examine the images of scientists presented in high school science textbooks. From this point of view, it is aimed to examine how the images of scientists are presented in the textbooks prepared for being used in secondary science courses in our country. It is intended to reveal the ratio of the concept of stereotyped scientists highlighted especially in the field literature in secondary textbooks in Turkey. Not only physical images of scientists but also their images of their scientific study characteristics have been evaluated in secondary science books. This is especially associated with the fact that students develop their understanding of the

nature of science by this way (Abd-El-Khalick et al., 2017; Acevedo-Diaz & Garcia-Carmona, 2016a; Acevedo-Diaz & Garcia-Carmona, 2016b; Oberheim, 2016; Wolfensberger & Canella, 2015). Canella, 2015). The students' perceptions about the nature of science are affected by the various factors such as the textbooks, teachers, social environment and media, etc. There has been an emphasis on the textbooks among the factors which will contribute to shaping students' perception about science in recent years. This is because, the recent studies reflect the attitude towards criticizing the stereotypical perception about the image of scientists in terms of the gender, physical appearance and working environment of the scientists especially in the textbooks. The majority of the figures of male scientist in terms of this stereotypical image of scientist in the textbooks is seen in the international literature and it is emphasized that this figure of male scientist threatens the class performances, interests and future career choices of female students in science courses. Based on these facts, it is aimed to determine the status of the image of scientists in the secondary science textbooks in Turkey. Moreover, this research is a comprehensive study including the research of all books prepared by both MEB publishing houses and private publishing houses in order to be used in common high schools and science high schools in all the field of secondary school science field today.

Given the effects of scientists in science textbooks on shaping students' image of science and scientists, it is a necessity to examine how scientists are presented in science textbooks in Turkey. From this point of view, the study is an examination of the scientists' images in textbooks prepared to be taught in the science courses at secondary schools in the 2018-2019 academic year in Turkey. Accordingly, answers to the following questions are sought:

1. What are the gender distributions of the scientists in secondary science textbooks in terms of class level, science field, and type of publishing house?
2. What are the nationality distributions of the scientists in secondary science textbooks in terms of class level, science field, and type of publishing house?
3. What are the physical characteristics of the scientists in secondary science textbooks in terms of class level, science field, and type of publishing house?
4. What are the working methods of the scientists in secondary science textbooks in terms of class level, science field, and type of publishing house?
5. What are the working environments of the scientists in secondary science textbooks in terms of class level, science field, and type of publishing house?

2. Method

In this study, document analysis which is one of the qualitative research methods is used. Document analysis includes analysis of written materials containing information about facts or facts intended to be examined (Simsek & Yildirim, 2011).

Sample

Compulsory gradual education which lasts 12 years (from 6 to 18 years) is implemented in Turkey. Secondary education is included in compulsory education and contains class levels between 9th grade and 12th grade. The language of science courses is Turkish in the majority of the schools. During an academic year, the total hours of science courses in Anatolian high schools are about 36 hours. In addition, the total hours of science courses in science high schools are around 49 hours (MEB-TTKB, 2018). Science courses are taught separately in three main fields: biology, physics and chemistry at the level of secondary education. Secondary school science textbooks in Turkey are prepared for the authors' committees for both MEB Publishing House and private publishing houses. These prepared books are used by both public and private high schools. The science textbooks for general high schools and science high schools are separately prepared in Turkey. This difference is written on the front covers of books. In total, 36 books should be examined for four grade levels (9th -12th grades) of secondary schools, but one for each book, from 9th grade's Biology by MEB Publishing House, 11th grade's Chemistry by Private Publishing House and 12th grade' Biology by Private Publishing House, could not be reached. These three books, which are not included in the sample, could not be obtained in print or digital form. In this context, the sample of the study consists of total 33 books instructed in science courses at secondary schools. The electronic versions of these textbooks are provided as PDF via EBA, a system that provides open access to course documents in Turkey. The imprints of the textbooks used in the study are presented in Table 1.

Table 1. Imprints of textbooks used in the study

Class	Biology	Physics	Chemistry
9A	-	MEB Publishing House	MEB Publishing House
9B	Netbil Publishing	Tutku Publishing	Sonuç Publishing
9C	MEB Publishing House (Science High School)	MEB Publishing House (Science High School)	MEB Publishing House (Science High School)
10A	MEB Publishing House	MEB Publishing House	MEB Publishing House
10B	Berkay Publishing	Berkay Publishing	Uygun Publishing
10C	MEB Publishing House (Science High School)	MEB Publishing House (Science High School)	MEB Publishing House (Science High School)
11A	MEB Publishing House	MEB Publishing House	MEB Publishing House
11B	Kök Publishing	Tutku Publishing	-
11C	MEB Publishing House (Science High School)	MEB Publishing House (Science High School)	MEB Publishing House (Science High School)
12A	MEB Publishing House	MEB Publishing House	MEB Publishing House
12B	-	Başak Publishing	Ipekyolu Publishing
12C	MEB Publishing House (Science High School)	MEB Publishing House (Science High School)	MEB Publishing House (Science High School)

Data Collection and Analysis

The data of the study are collected and analyzed in collaboration with both researchers. The study data are analyzed in the context of five themes described below in terms of class level, the type of publishing house and sciences. The researchers have first conducted a comprehensive literature survey on examination of the textbooks and established the appropriate coding systematics. In this context, different coding systematics in the related literature are brought together by the researchers and a coding systematic is adjusted for this study. Two researchers have completed the coding first by making comparisons separately and then together according to this created coding systematic. (Idin & Yalaki, 2016; Koseoglu & Durukan, 2017; Lacin-Simsek, 2011; Yacoubian et al., 2017). In this context, the studies of Yacoubian et al. (2017), especially in the literature, reveal a simple and systematic coding on textbooks. In this study, the data based on five themes are analyzed. These are:

1. Classifying scientists according to gender.
2. Classifying scientists according to their nationalities. This classification consists of two categories. These are classified as domestic (Non-Western) and foreign (Western) scientists.
3. Classifying scientists according to their physical characteristics. This classification includes four categories. These are classified as bald, spectacled, bearded and turbaned.
4. Classifying scientists according to their working methods. This classification consists of three categories. These are individual, group (team) and uncertain work.
5. Classifying scientists according to their working environment. This classification includes four categories. These are laboratory, nature, workroom and uncertain environment.

Textbooks are categorized by both researchers at a rate of 95%. Each category is calculated as frequency and percentage under five themes. The findings obtained as the result of the analysis process are presented according to the class level and science field and are supported by quotations.

3. Results

In this part of the study, there are descriptive analysis results on scientists' images in terms of presentation of their gender, nationality, physical characteristics, working methods and working environments in secondary science textbooks in Turkey. The results of study are provided as frequency and percentage values in five tables.

The results in Table 2 demonstrate the scientists' gender distributions in textbooks according to class level, type of publishing house and science field.

Table 2. The scientists' gender distributions

Class Level-Type of Publishing House	Biology		Physics		Chemistry	
	Male	Female	Male	Female	Male	Female
	f/(%)	f/(%)	f/(%)	f/(%)	f/(%)	f/(%)
9-A			7(4.1%)		13(11.6%)	
9-B	3(7.5%)		9(5.3%)		27(24.1%)	
9-C	3(7.5%)				34(30.4%)	1(0.9%)
10-A	1(2.5%)		3(1.8%)		4(3.6%)	
10-B	1(2.5%)		15(8.8%)		6(5.4%)	
10-C	1(2.5%)		8(4.7%)		4(3.6%)	
11-A	4(10%)		2(1.2%)	1(0.6%)	3(2.7%)	
11-B	2(5%)		8(4.7%)	1(0.6%)		
11-C	2(5%)			1(0.6%)	7(6.3%)	
12-A	8(20%)	2(5%)	17(10%)	1(0.6%)	4(3.6%)	
12-B			60(35.3%)	1(0.6%)	7(6.3%)	
12-C	11(27.5%)	2(5%)	35(20.6%)	1(0.6%)	2(1.8%)	

Note: A: MEB Publications, B: Private publishing house, C: MEB Publishing House (Science High School)

When Table 2 is examined, it is seen that the gender distribution of scientists in the textbooks is concentrated on male scientists in the 12th grade according to the class level. It is understood that the distribution of male scientists according to the field and type of publishing house in the level of 12th grade is physics and private publishing house (35.3%). However, it is seen that the image of male scientist stands out again in the 9th grade's field of chemistry in the types of private publishing house (24.1%) and MEB Publishing House (science high school) (30.4%). On the other hand, it is seen that female scientists are represented at low rates in the 12th grade's field of biology prepared by MEB Publishing House (5%) and MEB Publishing House (Science High School) (5%) and in the 11th and 12th grade's field of physics prepared by all the publishing houses (0.6%). This result of the research reveals the scarcity of female scientists according to gender distribution of scientists in secondary school textbooks. At the same time, it is determined that the gender distribution of scientists does not show a systematic and uniform distribution at all class levels. Sample citations are shown in terms of the gender of scientists in Figure 1.

Görsel 1.24: *Johannes Kepler*
(Temsili resmi)

Male Scientist: A picture representing Johannes Kepler, who explains the motion of planets around the sun based on Newton's law of gravitation (Kaderoglu et al., 2018, p.62, Image 1.24, Physics 12, MEB Publishing House).

Görsel 4.12: *Marie Curie*
(Temsili resmi)

Female Scientists: A picture representing Marie Curie studying on radioactivity (Kaderoglu et al., 2018, p.175, Image 4.12, Physics 12, MEB Publishing House).

Figure 1. Examples reflecting the gender of scientists in secondary science textbooks

The results of analysis representing the distribution of scientists according to their nationalities in high school science textbooks are given below in Table 3.

Table 3. The distributions of scientists according to their nationalities

Class Level-Type of Publishing House	Biology		Physics		Chemistry	
	Domestic	Foreign	Domestic	Foreign	Domestic	Foreign
	f/(%)	f/(%)	f/(%)	f/(%)	f/(%)	f/(%)
9-A				7(4.1%)	3(2.7%)	10(8.9%)
9-B		3(7.5%)	2(1.2%)	7(4.1%)	3(2.7%)	24(21.4%)
9-C		3(7.5%)			3(2.7%)	32(28.6%)
10-A	1(2.5%)		1(0.6%)	2(1.2%)		4(3.6%)
10-B		1(2.5%)	2(1.2%)	13(7.6%)		6(5.4%)
10-C		1(2.5%)		8(4.7%)		4(3.6%)
11-A	4(10%)		1(0.6%)	2(1.2%)	3(2.7%)	
11-B	2(5%)		1(0.6%)	8(4.7%)		
11-C	2(5%)		1(0.6%)			7(6.3%)
12-A	1(2.5%)	9(22.5%)	3(1.8%)	15(8.8%)	1(0.9%)	3(2.7%)
12-B			6(3.5%)	55(32.4%)	1(0.9%)	6(5.4%)
12-C	1(2.5%)	12(30%)	5(2.9%)	31(18.2%)	1(0.9%)	1(0.9%)

Note: A: MEB Publishing House, B: Private Publishing House, C: MEB Publishing House (Science High School)

When Table 3 is examined, it is seen that the scientists are gathered mostly in the 12th grade as foreign nationals (western) according to class level. In addition, it is observed that again foreign scientists (western) become intensely prominent also in the 9th and 10th grade's textbooks. However, it is understood that foreign scientists are mostly in the field of physics and in the textbooks prepared by private publishing houses according to the field of science and the type of publishing house [%32.4(9-B), %18.2(9-C), %8.8(9-A)]. It is observed that foreign scientists are represented in a large number again in all publishing house types of 9th grade's chemistry textbooks [28.6% (9-C), 21.4% (9-B), 8.9% (9-A)]. On the other hand, it is seen that the number of domestic scientists represented in the textbooks is very low at all class levels. When the distribution of domestic scientists is examined, it is understood that it is a bit more in the 11th grade's biology textbooks [10% (9-A), 5% (9-B), 5% (9-C)] in all publishing houses, in the 12th grade's physics textbooks [3.5% (9-B), 2.9% (9-C), 1.8% (9-A)] in all publishing houses and the 9th grade's chemistry textbooks [2.7% (9-A), 2.7% (9-B), 2.7% (9-C)] in all publishing houses than the other class levels. This result of the study reveals the scarcity of domestic scientists in the distribution of scientists according to their nationalities in the secondary school textbooks. Meanwhile, it is determined that the distribution of scientists according to their nationalities is not systematically and uniformly distributed at all class levels. Sample citations in terms of the scientists' nationalities are shown in Figure 2.

Görsel 4.5: *Feza Gürsey*

Domestic Scientist: A picture representing Feza Gursey who makes important researches on the theoretical subjects of physics (Kaderoglu et al., 2018, p.162, Image 4.5, Physics 12, MEB Publishing House).

Görse 4.3: *Erwin Schrödinger*

Foreign Scientist: A picture representing the Austrian physicist Erwin Schrödinger, who makes significant contributions to the development of quantum mechanics theory (Kaderoglu et al., 2018, p.160, Image 4.3, Physics 12, MEB Publishing House).

Figure 2. Examples reflecting the nationalities of scientists in the secondary science textbooks

Physical characteristics of the scientists in secondary science textbooks are given in Table 4.

Table 4. The distribution of scientists according to their physical characteristics

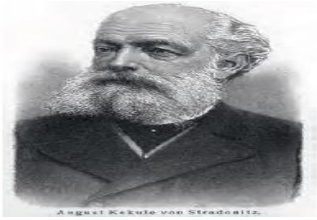
Class Level-Type of Publishing House	Biology				Physics				Chemistry			
	Spectacled	Bald	Bearded	Turbaned	Spectacled	Bald	Bearded	Turbaned	Spectacled	Bald	Bearded	Turbaned
	f/(%)	f/(%)	f/(%)	f/(%)	f/(%)	f/(%)	f/(%)	f/(%)	f/(%)	f/(%)	f/(%)	f/(%)
9-A					1(0.6%)		1(0.6%)		4(3.6%)	1(0.9%)	5(4.5%)	1(0.9%)
9-B			1(2.5%)			3(1.8%)	6(3.5%)	2(1.2%)	8(7.1%)	5(4.5%)	7(6.3%)	1(0.9%)
9-C	1(2.5%)		1(2.5%)						9(8%)	7(6.3%)	8(7.1%)	2(1.8%)
10-A	1(2.5%)						1(0.6%)	1(0.6%)	1(0.9%)			
10-B	1(2.5%)					1(0.6%)	5(2.9%)	2(1.2%)			1(0.9%)	
10-C							1(0.6%)	1(0.6%)	1(0.9%)			
11-A			3(7.5%)	3(7.5%)					2(1.8%)			
11-B	1(2.5%)	1(2.5%)	1(2.5%)	1(2.5%)								
11-C		1(2.5%)	1(2.5%)	1(2.5%)	1(0.6%)				2(1.8%)	1(0.9%)	1(0.9%)	
12-A	3(7.5%)	1(2.5%)			6(3.5%)	3(1.8%)	2(1.2%)		1(0.9%)	1(0.9%)		
12-B					18(10.6%)	12(7.1%)	12(7.1%)	3(1.8%)	3(2.7%)	1(0.9%)		
12-C	5(12.5%)	1(2.5%)	1(2.5%)		10(5.9%)	6(3.5%)	8(4.7%)	1(0.6%)				

Note: A: MEB Publishing House, B: Private Publishing House, C: MEB Publishing House (Science High School)

When Table 4 is examined, it is seen that the scientists in the textbooks are presented in the portrait of stereotypical scientists (spectacled, bald, bearded…) in terms of their physical characteristics. It is understood that these stereotypical features in terms of class level and science are most prominent in the field of chemistry in 9th grade and in the field of physics in 12th grade. The scientists depicted as spectacled are listed in the 12th grade's physics textbooks prepared by private publishing house [f = 18 (12-B)] and MEB publishing house (science high school). The scientists portrayed as bald are met mostly in 12th grade's physics textbooks prepared by the private publishing house [f = 12 (12-B)]. The bearded scientists are met mostly again in 12th grade's physics textbooks prepared by the private publishing house [f = 12 (12-B)]. It is understood that the turbaned scientists are found mostly in 11th grade's biology books by MEB Publishing House [f=3(11-A)] and in the 12th grade's physics books by private publishing house [f=3(12-B)]. These results of the research reveal the stereotypical perception of the scientists according to the physical characteristics of scientists in secondary school textbooks. In addition, it is determined that these stereotypes are differently distributed in terms of class level, science field and type of publishing house. Sample citations representing physical characteristics of the scientists are shown in Figure 3.

Spectacled Scientist: A picture representing Fritz London explaining induced dipole-induced dipole forces (Güntut et al., 2018, p.129, Visual 3.4.6, Chemistry 9, MEB Publishing House).

Bald Scientist: A picture representing Max Planck explaining the idea that energy is spreading quantum (Kaderoglu et al., 2018, p.201, Visual 5.6, Physics 12, MEB Publishing House).



Bearded Scientist: A picture representing August Kekule von Stradonitz, the scientist who first revealed the structure of the benzene molecule in 1965 (Yıldız & Sümer, 2017, p.137, Visual 3.19, Chemistry 10, Tutku Publishing).

Turbaned Scientist: A picture representing Ibn Sina, a scientist whose work named El-Kanun Fi't-Tıbb (Codes of Medicine) has been translated into Latin and taught as a textbook in medical education in the West (Tokgöz et al., 2018, p.33, Biology 11) (MEB Publishing House).

Figure 3. Examples reflecting the physical characteristics of the scientists in the secondary science textbooks

The findings related to the working methods of the scientists in secondary science textbooks are given in Table 5.

Table 5. The distribution of how the working methods of the scientists are described

Class Level-Type of Publishing House	Biology			Physics			Chemistry		
	Individual	Group	Uncertain	Individual	Group	Uncertain	Individual	Group	Uncertain
	f/(%)	f/(%)	f/(%)	f/(%)	f/(%)	f/(%)	f/(%)	f/(%)	f/(%)
9A				1(0.6%)		6(3.5%)			13(11.6%)
9B	1(2.5%)		2(5%)		1(0.6%)	8(4.7%)	1(0.9%)		26(23.2%)
9C			3(7.5%)						35(31.3%)
10A			1(2.5%)			3(1.8%)			4(3.6%)
10B			1(2.5%)		3(1.8%)	12(7.1%)			5(4.5%)
10C			1(2.5%)		2(1.2%)	6(3.5%)			4(3.6%)
11A			4(10%)	1(0.6%)		2(1.2%)			3(2.7%)
11B			2(5%)	2(1.2%)		7(4.1%)	1(0.9%)		
11C			2(5%)			1(0.6%)			7(6.3%)
12A		7(17.5%)	3(7.5%)			18(10.6%)			4(3.6%)
12B				2(1.2%)	7(4.1%)	52(30.6%)			7(6.3%)
12C	1(2.5%)	4(10%)	8(20%)	2(1.2%)	2(1.2%)	32(18.8%)		1(0.9%)	1(0.9%)

Note: A: MEB Publishing House, B: Private Publishing House, C: MEB Publishing House (Science High School)

When Table 5 is examined, it is understood that the vast majority of scientists in the textbooks are depicted uncertain in terms of working methods. The working methods of the scientists are uncertain in terms of class level, the field of science and the type of publishing house highly in the 9th grade's chemistry by MEB publishing house (science high school) [f = 35 (9-C)] and 12th grade's physics by private publishing house[f=52(12-B)]. The depiction of the scientists' teamwork is seen mostly in the 12th grade's biology textbooks by MEB Publishing House [f=7(12-A)] and 12th grade's physics textbooks by private publishing house [f=7(12-B)] in terms of class level, science and the type of the publishing house. This result of the study shows that the secondary school textbooks fall short of depicting the field of scientists and the systematic of scientific research according to the scientists' working methods. Sample citations representing working methods of the scientists are shown in Figure 4.

Scientist doing self-study: A picture representing Canan Dağdeviren, who gets through making a wearable pacemaker that can convert and store the mechanical energy of internal organs into electrical energy (Gür & Yılmaz, 2018, p.157, Visual 1.84, Physics 11, Tutku Publishing).

Scientist Studying in a Team: A picture representing scientific research in a team (Hepdoğru, 2018, p.35, Visual 1.41, Physics 9, Tutku Publishing).

Scientist whose Working Method is Uncertain: A picture representing John Dalton, one of the first scientists to lay the foundation of today's atomic theory (Çiftci et al., 2018, p.178, Visual 4.1.1, Physics 12, MEB Publishing House-Science High School).

Figure 4. Examples reflecting the working methods of the scientists in the secondary science textbooks

The findings on the working environments of the scientists in secondary science textbooks are given in Table 6.

Table 6. The distribution of how the working environments of the scientists are depicted

Class Level-Type of Publishing House	Biology				Physics				Chemistry			
	Laboratory	Nature	Studying Room	Uncertain	Laboratory	Nature	Studying Room	Uncertain	Laboratory	Nature	Studying Room	Uncertain
	f/(%)	f/(%)	f/(%)	f/(%)	f/(%)	f/(%)	f(%)	f/(%)	f/(%)	f/(%)	f(%)	f/(%)
9A						1(0.6%)		6(3.5%)				13(11.6%)
9B			1(2.5%)	2(5%)		1(0.6%)		8(4.7%)	1(0.9%)			26(23.2%)
9C				3(7.5%)								35(31.3%)
10A				1(2.5%)				3(1.8%)				4(3.6%)
10B				1(2.5%)				15(8.8%)			1(0.9%)	5(4.5%)
10C				1(2.5%)			2(1.2%)	6(3.5%)				4(3.6%)
11A				4(10%)	1(0.6%)			2(1.2%)				3(2.7%)
11B				2(5%)	1(0.6%)	1(0.6%)		7(4.1%)				
11C				2(5%)				1(0.6%)				7(6.3%)
12A				10(%7.5)				18(10.6%)				4(3.6%)
12B					5(2.9%)	2(1.2%)	2(1.2%)	52(30.6%)				7(6.3%)
12C	1(2.5%)			12(30%)		2(1.2%)	2(1.2%)	32(18.8%)			1(0.9%)	1(0.9%)

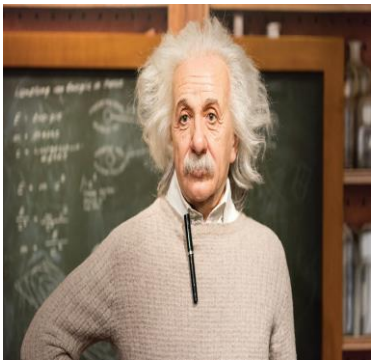
Note: A: MEB Publishing House, B: Private Publishing House, C: MEB Publishing House (Science High School)

When Table 6 is examined, it is understood that a great majority of the scientists in the textbooks are unclearly depicted in terms of working environments. The ambiguity of the scientists' working environments is high in the 9th grade's chemistry textbooks by MEB Publishing House (science high school) [f=35(9-C)] and 12th grade's physics textbooks by private publishing house [f=52(12-B)] in terms of class level, science field and the type of the publishing house. It is seen that the depiction of the scientists studying in the laboratory is mostly in the 12th grade's physics textbooks by private publishing house [f=5(12-B)] in terms of class level, science field and the type of the publishing house. After all, the depictions of scientists in nature [f=2(12-C-Physics)] and in the studying room [f=1(12-Chemistry)] are again too low in only a few books. This result of the study shows that the secondary school textbooks fall short of realistically depicting the scientists' working environments. Sample citations representing working environments of the scientists are shown in Figure 5.

Scientist studying in the laboratory: A picture representing Henry Mosele, who discovers that there is a correlation between the energy of the X-rays and the atomic number of the elements (Avcı, 2018, p.63 Visual 2.3.2., Chemistry 9, Sonuç Publishing).

Scientist studying in the nature: symbolic picture of Benjamin Franklin's kite experiment (Hepdoğru, 2018, p.276, Visual 6.11., Physics 9, Tutku Publishing).

Scientist in the studying room: A picture representing Antony van Leeuwenhoek, the first person to examine pool water under a microscope (Suna, 2018, p.77, Visual 2.2a., Biology 9, Netbil Publishing).



Scientist whose work environment is uncertain: A picture representing physicist Albert Einstein who explains in his special theory of relativity that the speed of light is not affected by the movement of the source or observer, and that speed is always c (Çifci et al., 2018, p.238, Visual 5.1.3, Physics). 12, MEB Publishing House-Science High School).

Figure 5. Examples reflecting the working environments of the scientists in the secondary science textbooks

4. Discussion and Conclusion

It is examined how the scientists' images are in the secondary school science textbooks in Turkey in this study. The following five basic conclusions are made out within the scope of the study.

In the history of science it can be said that the number of female scientists is relatively less than that of men. However, it can be said again that the image of the scientist (Women≠Scientist, Man=Scientist) is not thoroughly reflected in the context of gender when the scientists breaking grounds about inventions and researches are examplified in our modern science world . Therefore it is substantial to pay regard to the balance between female and male while the image of the scientists are being reflected as part of gender in the textbooks. Because, it is empsasized the fact that the intensity of male scientists is highlighted in the stereotypical image of the scientists substantially affects especially female students' performances about the science, their career planning in science, their expectations upon STEM careers and their belief about women cannot be a good scientist. (Bazler & Simonis, 1991; Carli, Alawa, Lee, Zhao & Kim, 2016; Good, Woodzicka & Wingfield, 2010). First of all, it is found that the image of male scientist are much more prominent than the female scientist in the distribution of scientists in secondary school textbooks according to gender. In addition, it is seen that there is no balanced distribution for the scientists in terms of gender in the evaluation made according to class level, the field of science and the type of the publishing house. The number of the female scientists are quite less than the number of the male scientists in the history of science; so the fact that the number of male scientists is more than that of male scientists according to the gender distribution of scientists in the textbooks in Turkey is an expected situation. It is understood that these results of the study are in parallel with many studies in the literature (Idin & Yalaki, 2016; Karaçam et al., 2014; Koseoglu & Durukan, 2017; Laçin-Şimşek, 2011). The negativity of the prevailing appearance of male scientists in the literature in the course materials is especially associated with the decrease in female students' interest in science. It also reveals that such a dominant male scientist image makes female students think that a scientist should be male. (Charles & Grusky 2004; Unver, 2010; Yacoubian et al., 2017). However, the fact that the scientists in the textbooks are male can cause students to have the image of stereotyped scientists (Aggul-Yalçin, 2012; Unver, 2010). Therefore, considering the similar situation in textbooks in Turkey, it is essential to increase the number of female scientists' examples from both the history of science and modern-day for the career choices of female students in order to become scientists in the future. If this is possible, it can be said that the positive steps towards female students' perceptions of scientists and gender justice will be taken through textbooks.

In the light of the second result of the study, it is seen that the scientists are mostly foreign (Western/European) according to the distribution of the nationalities in the textbooks, whereas the number of domestic scientists (Non-Western) is too low. Besides, it is understood that the distribution of the scientists according to their nationalities is neither systematic nor uniform in terms of class level, the field of science and the type of the publishing house. The results of previous studies on science textbooks at different levels support this conclusion of the research (Idin &Yalaki, 2016; Köseoglu & Durukan, 2017). Yacoubian et al. (2017) has pointed out in their research that an image which the history of science focuses on western scientists has been embedded in textbooks, which is a distorted understanding of the history of science. It can be said that textbooks, predominantly visualized with western scientists, will instill an understanding of science that begins and continues with Europe as an accepted fact. However, it is known that Islamic civilization and other civilizations have made significant contributions to laying the foundations of contemporary science throughout history. However, it may lead future generations to accept the notion that contemporary science is only done in the western world. Therefore, it is clear that perception of this stereotyped western scientist in the secondary school science textbooks in Turkey needs to be balanced with Non-Western scientists and from other civilizations.

The third result of the study reveals that the scientists are stereotypical, for example, spectacled, bald and bearded according to their physical characteristics in the textbooks. In addition, it is determined that these stereotypes are quite differently distributed in terms of class level, science field and the type of publishing house. This result of the study show is in parallel with the conclusion of many studies in the literature (Christidou et al., 2012; Ramnarain & Chanetsa, 2016; Villar & Guppy 2015; Yacoubian et al., 2017). It can be inferred that this result of the study does not reflect understanding of contemporary scientists in particular nowadays and that it will lead students to approach this stereotypical understanding of scientists negatively.

The fourth result of the study shows that the vast majority of scientists in the textbooks are portrayed indefinitely in terms of working methods. It is found that the textbooks remain very weak in terms of class level and the type of publishing house, in particular, scientists are weak in terms of visuals reflecting their own field of study systematic. This finding of the research is supported by some study results in the literature (Yacoubian et al., 2017). This result of the study can be associated with the effects on the students' ways of understanding the nature of science in particular (Abd-El-Khalick, Waters & Le, 2008; Ramnarain & Chanetsa, 2016). The representations related to the scientists' working methods in science textbooks enable students to gain insight about the ways through which scientists research science. The fact that the working methods of scientists cannot be clearly depicted in the textbooks may lead students to have ambiguous ideas about how the scientific studies are conducted. However, many scientific discoveries from past to present have emerged as the product of teamwork. Today, considering the complexity of the field of science and its interdisciplinary relationship, it can be said that it puts forward an understanding that requires the scientists to work as a team. Thus, it can be said that the working images of scientists are far from representing this in the science textbooks in Turkey today.

The fifth conclusion of the study shows that textbooks remain weak in that they depict scientists' working environment in a real or realistic way. Moreover, it is understood that the scientists' working environment is unclear in the vast majority of the textbooks. It is found that the textbooks remain very weak in terms of class level and the type of publishing house, especially in terms of the fact that science field on which the scientists themselves study is reminiscent of the research field. It can be said that depicting the working environments of the scientists depending on the science field in the science textbooks will make significant contributions to the development of students' understanding the nature of science. In other words, to be depicted in nature while working on a plant in biology, to be depicted in a laboratory with test tubes and chemicals in chemistry, and to be depicted while working in front of a board filled with icons, numbers and formulas in physics.

It is thought that clarifying the physical characteristics of scientists as well as working environments will positively affect students' understanding of the nature of science. In this sense, it is determined that the workings, working conditions and thinking skills of scientists are not sufficiently included in the seconday science textbooks in Turkey.

Scientists are often portrayed as stereotypes who work alone, wearing gowns, wearing glasses, bald, messy hair, working in the laboratory, always trying to discover something with mice, rabbit, chemicals and test tubes. Considering the results of this study in its entirety, it can be said that the image of a stereotyped scientist in terms of class level, field and type of publishing houses is intensely preferred in the secondary school science textbooks in Turkey. In particular, it is thought that one of the most important sources of images that students create for scientists may be textbooks. Therefore, the textbooks that will be prepared for being used in the secondary school science courses today should reveal the more realistic image of a scientist who will contribute to students' understanding the nature of science.

5. Suggestions

In line with the results above, the following suggestions can be made to the researchers and those who will prepare textbooks in the future: The image of scientists in secondary school textbooks of successful countries in the field of science should be compared with the images of scientists in Turkey. In addition, the gender, nationality and physical characteristics of the scientists in the books should be supported by the image of modern scientists, in addition to the image of the stereotyped scientist today. Besides, the working methods and environments of scientists should be depicted more realistically in textbooks and supported with the texts from the history of science. Not only are a single portrait and discovery of the scientists simply described but the chapters about history of science which can reflect their scientific working methods and environments related to the subjects in the unit from past to present should also be used at the end of each unit of the books. It is thought that the scientists presented in the textbooks should be from different genders, different cultures, and different fields of science in order to change the image of the stereotyped scientists. In particular, the scientific studies which female scientists do and slice of their life stories should be placed in textbooks. The number of female scientists in textbooks should be increased in order to encourage female students by making positive discrimination. However, Non-Western scientists should be included more in the textbooks. This is because it is thought that such an arrangement will positively affect the perception of Turkish students about the contribution of their nation and civilization to science. Finally, textbooks can be supported by additional video materials that document the discoveries of some scientists.

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