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Original Research

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The Effect of Scenario-Based Learning on Eighth-Grade Students' Perceptions of Scientists

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Abstract

The aim of our study was to investigate the effect of scenario-based learning on eighth-grade students' perceptions of scientists. We used a semiexperimental design to conduct our research with 36 students from the eighth grade, who were divided into experimental and control groups. We collected the data through a "Draw-a-Scientist Test," an opinion form, and semistructured interviews. According to the findings we obtained from the drawing test, students have stereotypical perceptions of the scientists' working environment (indoor/laboratory). But the results showed that scenario-based teaching affects eighth-grade students' perceptions of scientists and moves them forward on two points: (1) the physical appearance of the scientist (drawing characteristics in the head area, accessories, clothing features, etc.) and (2) symbols of knowledge (encyclopedia/books/notebook, writing board) and research (test tube, magnifying glass, experiment glasses, etc.). In the light of these findings, we propose some suggestions regarding the use of scenarios in education to affect students' perceptions of scientists.

Keywords: *scenario-based learning, students' perceptions of scientists, science education*

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Introduction

For more than 50 years, researchers have been trying to identify how individuals from various age groups in different countries perceive scientists. Considering the skills required and the professions expected to be chosen by 21st-century individuals, students' perceptions of science and scientists have become even more important. Scientist perception determination tests, which have different versions (like opinions, interviews, and written explanations), are used to determine perception of scientists. Drawings are the most often used tools in determining the perceptions of science and scientists (Chang et al., 2020). The drawings can play a central role in determining children's views of the world and their beliefs about science and scientists, shaping their interest in science (Ferguson & Lozette, 2020) and determining their scientific careers (Bozzato et al., 2021). Although the drawings eliminate the linguistic difficulties that may arise in terms of expressing individuals' thoughts (Fiorella & Zhang, 2018), supporting the drawing with tools, such as written explanation (McCarthy, 2015; Reinisch et al., 2017; Toma et al., 2018) and interviewing (Farland-Smith et al., 2017), enables individuals to express their thoughts in many ways and is more reliable in determining the perception of what a scientist is. Students studying in a curriculum and education system in which they actively participate have learned science more comprehensively (Thomson et al., 2019), have a more positive perspective of scientists (Taylor et al., 2022), and have a more extensive perspective in drawings of scientists (Medina-Jerez et al., 2011). Books, especially commercial books, have been effective in forming children's scientific identities and their thoughts as scientists (Farland-Smith et al., 2017). Similarly, children reading stories about scientists contributes to their views toward science and scientists (Christidou et al., 2021). In the scientific scenarios in our study, scientific information is conveyed by characters, and some characters are scientists. From this point of view, teaching methods and strategies used in the learning environment may have an impact on students' perceptions of scientists. Therefore, the purpose of our research was to examine the effects of scenario-based learning on eighth-grade students' perceptions of scientists.

Literature Review

Perception of Scientists

In an earlier study of individuals' perceptions of scientists, the scientists had features such as wearing a white lab coat, wearing glasses, working with glass materials like a tube-bottle, and having a grumpy and eccentric expression on their faces (Mead & Metraux, 1957). Following this study, Chambers (1983) developed the Draw-A-Scientist Test (DAST) tool to determine an individual's perceptions of a scientist. Although this tool is often called a test, it consists of the examination of the drawings of a scientist (Chambers, 1983). In the drawings characterizing a scientist, these categories are expressed as white lab coat, glasses, beard or mustache; use of laboratory equipment, books, or information symbols; items related to new technological instruments or inventions; and "Eureka" style subtitles (Finson et al., 1995). As the age level increases, the detail in the drawings in the mentioned categories increases. Many recent studies we examined on the perceptions of scientists are similar to the results of Chambers's work (Bozzato et al., 2021; Emvalotis & Koutsianou, 2018; Farland-Smith et al., 2017; Ferguson & Lezotte, 2020; Lei et al., 2019; Meyer et al., 2019; Miller et al., 2018; Reinisch et al., 2017; Türkmen, 2008).

According to studies conducted in different societies and age groups, the perceptions of scientists are affected by many factors. Although the exact source of the perception of a typical scientist among students cannot be identified (Medina-Jerez et al., 2011), children learn about science and the scientist from various places (Farland-Smith et al., 2017), which includes resources outside the school as well as those within the school. According to Miller et al. (2018), teachers convey their opinions to their students and students may adopt the opinions of their teachers. Therefore, teachers should pay attention to their own personal and professional attitudes as these may affect their students (Taylor et al., 2022). The type of school (public school, private school, etc.; Medina-Jerez et al., 2011), grade level (Bozzato et al., 2021; Emvalotis & Koutsianou, 2018; Thomson et al., 2019), as well as their teachers' opinions (El Takach & Yacoubian, 2020) can all affect students' perceptions of scientists. In addition, the media plays an important role in eighth-grade students' perceptions of scientists (Bozzato et al., 2021; Farland-Smith et al., 2017; Ferguson & Lezotte, 2020; Hagenkötter et al., 2021; Takahashi & Tandoc, 2016), including written sources like books (El Takach & Yacoubian, 2020; Farland-Smith et al., 2017; Finson et al., 2018; Miller et al., 2018; Yacoubian et al., 2017), comics (Lamminpää et al., 2023), and newspapers (Thomson et al., 2019; Mergoupi-Savaidou et al., 2012). Students' perceptions of scientists are also affected by TV programs and movies (Gormally & Inghram, 2021; Hagenkötter et al., 2021; Thomson et al., 2019). Students' perceptions of the scientist personally identify with the role of a well-known scientist in the media. For instance, students' tendency to draw female scientists increases with female characters in the leading roles in TV shows (Hagenkötter et al., 2021). There are "superwoman" drawings of female scientist characters because students view that if a woman became a scientist, she must be superior (Robinson et al., 2020). In addition, male individuals place more unrealistic pictures in the scientist drawings inspired by science fiction characters (Tan et al., 2015). In Chambers's (1983) study, science fiction character drawings, such as Frankenstein, were found in student drawings. Moreover, cultural factors play an important role in students' perceptions of scientists (Chang et al., 2020; Emvalotis & Koutsianou, 2018; Kang et al., 2019; Miller et al., 2018), but it is understood that students' perceptions are independent of the country or age of the student. Christidou and Kouvatas (2011) examined pictures of Greek scientists on their websites, stating that there are many typical scientist characteristics in the paintings/photographs of scientists. On the other hand, Farland-Smith et al. (2017) examined the scientist images in the books on the *National Science Teacher's Association Recommends List* in the last 3 years and found a dominance of male images. Apart from these, important factors affecting the perceptions of science and scientists are the methods, techniques, and strategies used by teachers in school science programs, such as scenario-based learning.

Scenario-Based Learning and Perception of Scientists

Although the scenarios are expressed as stories about people and their activities, scenario-based learning is a type of expression created with daily and real-life problems related to the target theme or acquisition, in which the desired skills are presented to students in a planned manner as a whole (Temur & Turan, 2018). At this point, the scenario should be especially related to real life, the visuals should be selected according to the scenario, and the examples should be appropriate (Bell & Page, 2003). The primary aim of scenario-based learning is for students to view real-life problems through scenarios from different perspectives, approaching them critically and reaching learning goals by trying to solve these problems. Scenarios provide students with the opportunity to find solutions to problems with their knowledge and provide awareness of any gaps in their knowledge and skills (Owens et al., 2020). Scenario-based learning is a method that supports the constructivist learning approach that takes the student to the center (Chermack & Merwe, 2003). In this understanding of learning, students can realize meaningful learning through scenarios by integrating real-world problems with a constructivist approach into the classroom environment (Çubukçu, 2012, pp. 551–552).

In the process of performing meaningful learning, students' understanding of science concepts affects their perceptions of science and scientists (Chang et al., 2020; El Takach & Yacoubian, 2020; Gandolfi, 2018). The perception of scientists is said to be affected especially by in-school (Ferguson & Lezotte, 2020; Lei et al., 2019; Meyer et al., 2019; Takach & Yacoubian, 2020; Türkmen, 2008) and out-of-school resources (Ateş et al., 2021; Gormally & Inghram, 2021; Heitger & Milner, 2017; Hite & White, 2022; Kang et al., 2019; Tan et al., 2015). One of the factors contributing to the perception of the scientist may be science teaching practices (Farland-Smith et al., 2010). In this context, textbooks, teaching programs, and methods affect students' perceptions of scientists. Therefore, teaching courses with a teaching method that can enable students to learn about science-related subjects, analyze events, and use decision-making processes more effectively will affect their understanding of scientific knowledge positively. If sociological issues are handled with scenarios associated with daily life in the science teaching environment, students can draw conclusions about their content more easily and with scientific qualifications. Accordingly, their achievements and perceptions regarding science and scientists, especially science content, may change. For this reason, our study examined the effect of scenario-based learning on eighth-grade students' perceptions of scientists.

Methods

Research Design

Our study was conducted in a science course in a secondary school in the Aegean region of Turkey during the second semester of the academic year 2018–2019. Our study followed the semi-experimental pattern with an unequal control group, which is one of the pretest-posttest control group patterns.

Participants

Our study group consisted of 36 students studying at the eighth-grade level in a secondary school. The experimental group included 10 girls and 8 boys, and the control group comprised nine girls and nine boys. Students' ages ranged from 13 to 14 years. While presenting our study, the names of the students were not used, and codes were given to the control (CG1-CG18) and experiment (EG19-EG36) group students. *"EGP: experimental group-pretest, EGO: experimental group-posttest, CGP: control group-pretest, CGO: control group-posttest"* coding was used in the study.

Data Collection

The Draw-a-Scientist Test, developed by Chambers (1983), was used as a data collection tool, and data triangulation was done with the opinion form and semistructured interviews. The opinion form included the questions used in the semistructured interview. With the opinion form, the students' opinions of the application process learned using scenario-based learning and of scientists were given. An example of the opinion form questions follows:

> What are your views on the teaching of the "DNA and Genetic Code" unit in the 8th grade science course with scientific scenarios? Did this learning process affect your perceptions of scientists? If your answer is "Yes," can you explain how and why it affects your views/perceptions?

After the applications, semistructured interviews were conducted with the students in the experimental group. The one-on-one interviews were conducted with five volunteer students, and focus group interviews were held with five different students. Student opinions in the opinion form were deepened with semistructured interviews. In this context, more than one measurement tool was used for the same purpose, so detailed research was carried out by data diversification (Cohen et al., 2018).

Procedure

Nine scientific scenarios were prepared to be used in the research. In Turkey, a central application of the same science program is implemented, regardless of the province, district, etc. The basic subjects and concepts are clear for the DNA and Genetic code unit at the eighth-grade level in this program. Within the scope of our study, this subject and concept content was taken as a basis in the preparation process of the scenarios. Subject and concept content are presented in Appendix A. In the scenarios, a problem situation was given that includes situations with dilemmas. Students were expected to produce a solution to this problem situation or to accompany a scientist in the scenario to the solution process. The data collection process in the study lasted for 9 weeks. In this process, a science program supported by scenario-based learning was applied to the experimental group students. With the control group students, the course process was carried out according to the existing science program (inquiry-based learning). In the application process of the data collection tool, there was no restriction on the use of drawing paper and crayons by the students. No guidance was given to the students about the drawings of scientists. The pictures drawn by the students were first examined by all researchers in general, and the necessary themes were determined. After this process, the pictures drawn by the students were first examined separately by the classroom teachers and two researchers and evaluated according to the checklist (Appendix B). In addition, some features (proud facial expression, professor, guinea pig, etc.) in the student drawings unique to this study, which were not encountered in studies using the checklist, were included in the codes created under the appropriate themes. In the checklist, additional simulated scientists' components were added to increase interrater reliability and expand the stereotypical features that the measurement tool could capture. To ensure the content validity of the research, the adapted checklist and the prepared scientific scenarios were submitted to the expert judgment of five science experts. Member checking was taken to increase the internal validity of the study. First, the students answered the questions in the opinion form in writing. Afterward, semistructured interviews were conducted with the students. The same questions were used in the opinion form and semistructured interviews. In our study, different data sources and different data collection methods were used to ensure credibility (internal validity). To ensure external validity in the study, the characteristics, environment, and application process of the entire research sample were specified in detail. In addition, direct quotations were made from the opinion form, the answers of the students in the interviews, and the students' descriptions of their drawings.

Data Analysis

For the Draw-a-Scientist Test used in the study, all researchers examined the drawings by the students and analyzed those drawings under the themes of physical appearance of scientists, symbols used, work environment, and work style/methods. Later, by using previous studies on the subject (Chambers, 1983; Deniş & Erduran Avcı, 2015; Finson et al., 1995), codes related to themes were created. With the analysis developed by Chambers (1983), the drawing of the scientist was divided into seven main characteristics. Finson et al. (1995) developed a checklist to make this analysis easy: (a) physical appearance, (b) research symbols, (c) knowledge symbols, (d) facial expressions, (e) work environment, (f) the way of working, and (g) simulated scientist. The pictures drawn by the students were first examined separately by the classroom teachers and four researchers and evaluated according to the checklist. After the checklist was completed, the two researchers separately evaluated the drawings of the students according to the themes and codes. The result was 0.93 according to the interrater concordance formula developed by Miles and Huberman (2019).

Content analysis was used in the analysis of the opinion form. Content analysis is a process that begins with data collection and ends with category and code extraction (McMillan & Schumacher, 2010). In this context, the data related to each question were examined separately by the researchers; the codes were extracted and collected under certain themes. Then, according to the model by Miles and Huberman (2019), the coherence between the coding made by the researchers was calculated and found to be 0.90. Semistructured interviews were presented with direct quotations in a way that would strengthen the data obtained from other data collection tools by analyzing them with descriptive analysis, because descriptive analysis is used to make complex situations understandable by drawing a picture of what a situation, person, or event looks like (Punch, 2005).

Results

Results Related to the Image of Scientists

In this section, we examine the physical appearance, symbolic features, working environment, and working method/style-related features of the drawings made before and after the applications.

Physical Appearance

Pretest-posttest frequency and percentage values of the experimental and control group students regarding the physical appearance of the scientist are shown in Table 1.

Table 1. *Frequency and Percentage Values Related to Physical Appearance*

Theme	Category	Experimental Group				Control Group			
		Pretest		Posttest		Pretest		Posttest	
		f[a]	%[b]	*f*	%	*f*	%	*f*	%
Appearance in the head area	Messy hair	2	8	8	30.8	4	16.0	6	24.0
	Bald/partially lost hair	5	20	4	15.4	4	16.0	3	12.0
	Other	5	20	4	15.4	2	8.0	0	0
	Well-groomed hair	4	16	4	15.4	4	16.0	4	16.0
	Upright hair	3	12	3	11.5	3	12.0	5	20.0
	Beard/mustache	5	20	0	0	5	20.0	3	12.0
	Curly hair	1	4	2	7.7	2	8.0	3	12.0
	White hair	0	0	1	3.8	1	4.0	1	4.0
Accessories	Glasses	11	55	10	52.7	12	60.0	9	45.0
	Accessory not specified	5	25	5	26.2	3	15.0	5	25.0
	Hair clasp/belt/tie/ foulard/badge/ necklace/nose ring	4	20	4	21.1	5	25.0	6	30.0
Clothing features	Casual/sportswear	9	50	8	44.4	9	50.0	9	50.0
	Uncertain	6	33.2	3	16.7	0	0	2	11.1
	Lab coat	1	5.6	7	38.9	6	33.3	4	22.2
	Suit	1	5.6	0	0	2	11.1	3	16.7
	Vest	1	5.6	0	0	1	5.6	0	0
Scientist's facial expression	Happy	14	77.9	12	66.8	14	77.8	9	50.0
	Proud	2	11.1	1	5.5	2	11.1	2	11.1
	Distressed/frustrated	0	0	2	11.1	0	0	0	0
	Tired	0	0	2	11.1	0	0	0	0
	Considerate	0	0	0	0	0	0	2	11.1
	Crazy	0	0	1	5.5	0	0	1	5.6
	Unhappy	1	5.5	0	0	0	0	0	0
	Uncertain	1	5.5	0	0	2	11.1	4	22.2
Age	Uncertain	8	44.4	6	33.3	4	23.5	8	44.4
	Young	5	27.8	7	38.9	8	47.0	5	27.8
	Old	5	27.8	5	27.8	5	29.5	5	27.8
Simulated scientist	Uncertain	15	83.5	11	61.1	18	94.7	16	88.9
	Thomas Edison	1	5.5	2	11.1	0	0	0	0
	Albert Einstein	1	5.5	2	11.1	0	0	2	11.1
	Gregor Johann Mendel	1	5.5	0	0	0	0	0	0
	Professor	0	0	2	11.1	1	5.3	0	0
	The student himself	0	0	1	5.6	0	0	0	0

Note:
[a]*f* is the frequency of the student drawing properties The student may have stated more than one drawing feature, explanation, or opinion.
[b]% is the frequency percentage of student drawing properties.

Table 1 shows that the biggest shift from the pretest to the posttest was in messy hair (pretest *f* = 2, posttest *f* = 8). Looking at the descriptions of the students' drawings, explanations included "Time is the most valuable thing for scientists. For this reason, he never touched his hair. Yes, it may seem strange (messy hair), but as I said, time is very precious for them" (EGP28). The frequency of using well-groomed hair (*f* = 4) and upright hair (*f* = 3) in the drawings did not vary between pretests and posttests. It is noteworthy that beard/mustache (*f* = 5) drawings, which were frequently in the pretests, were not encountered in posttests. EGP31, who used a beard in the pretest drawing, explained this use by saying that "Thomas Edison has an important beard. And this beard made Edison look handsome," which revealed the perception of the beard. When the features in the head region of the drawings of the control group students were examined, the messy hair feature (pretest *f* = 4, posttest *f* = 6) was used before and after the applications. Opinions such as "The hair of the scientist is always messy" (CGP17) and "The scientist is working hard, cannot take care of himself, hair and beard are messy like in the picture" (CGP15) were examples of thoughts on messy hair drawings. Participants drew bald/partially lost hair drawings because of perceptions such as "Generally, scientists start to lose their hair because of hard work and stress" (CGO3); "Hair shed from working" (CGP12); and "A bald, tall and clever scientist with very little belly, wearing a lab coat, with hair only from the sides" (CGO12). The students who drew the scientist with curly hair gave explanations such as "When I see scientists, they usually have curly hair" (CGO2); "If you ask me why I drew curly hair, I think some curly-haired people are clever" (CGP7); and "Usually according to me, men with curly hair and glasses are more intelligent" (CGO7). The students' explanations indicate that they believe the reason why scientists have curly hair is their intelligence. Also, when the drawings related to the head region of the scientist were examined, it is important to note that the participant (CGP1) had the opinion, "The color of his hair is black. Because I think black is symbolic of determination."

When looking at the use of accessories in the drawings, eyewear accessories were most often used in both experimental (pretest *f* = 11, posttest *f* = 10) and control (pretest *f* = 12, posttest *f* = 9) groups. Among the experimental group students, EGO34 explained the use of glasses in his drawing: "I drew glasses because all the intelligent people I know wear glasses." The control group students gave explanations such as "I think a scientist should be wearing glasses because glasses are smart" (CGO15); "Usually, men with curly hair and glasses seem smarter to me" (CGO7); and "They have glasses because they are indispensable for a scientist" (CGP16). However, we noted that the drawings not using accessories and/or using accessories such as a hair clip, belt, and tie did not differ significantly from the pretest to posttest in both groups.

In terms of dressing characteristics, daily and sports dress were the most common clothing feature used in both groups' pretest and posttests (experiment pretest *f* = 9, experiment posttest *f* = 8, control pretest *f* = 9, control posttest *f* = 9). In the explanations related to the drawings, students stated, "The reason why I give this outfit to the scientist is because I want to show that a scientist can be a normal person" (EGP32) and "I dressed the scientist in blue because it is the symbol of purity, the scientist I drew is a pure scientist who is confident and this is what makes him different from the others" (CGO1). In addition, from the pretest to the posttest, the lab coat drawing increased in the experimental group (pretest *f* = 1, posttest *f* = 7) and decreased in the control group (pretest *f* = 6, posttest *f* = 4). The students explained their use of this clothing: "I drew lab coats because they [the scientists] are very meticulous and organized. They wear white lab coat to keep their clothes clean or safe when dealing with dangerous works" (EGP19), and "I made the lab coat white because the white coat gives scientists a different and scientific appearance" (CGP12).

When facial expressions were examined, scientists were happy in the pretest and posttest drawings of both groups (experimental pretest *f* = 14, experimental posttest *f* = 12, control pretest *f* = 14, control posttest *f* = 9). Though the percentages of working groups using these drawing features were approximately the same before the applications, the happy face expression drawing (experiment: 66.8, control: 50.0) in the experimental group was used more at the end of the applications. Statements by the students about drawing scientists' happy expressions: "He laughs because he is happy because he enjoys his work" (EGP34); "People who draw the scientist should draw them as a smooth-faced, happy face, and a good person" (CGP13); and "Whatever happens, scientists are happy" (CGO3). When the drawings were examined in terms of the age characteristics of the scientists, it was seen that uncertainty ($f = 8$) prevailed in the experimental group, whereas the young scientist drawings ($f = 7$) prevailed in the posttest. However, this was the opposite of the control group (pretest young $f = 8$, posttest uncertain $f = 8$). In the explanations they made only about the old scientist drawings, the students used the expressions: "I drew the elderly because it is hard to be a scientist and they are getting older over the years" (EGO19), and "My scientist is old because they have done this job for many years" (CGP12). In the study, some students also referred to famous scientists. Looking at the last tests, the names of Thomas Edison ($f = 2$), Albert Einstein ($f = 2$), and the students' professor ($f = 2$) were more frequently included in the experimental group after the applications, but only Albert Einstein ($f = 2$) was in the control group.

Examples from drawings of the experimental and control group students concerning the physical appearance of the scientist are presented below.

Figure 1. *Drawing of Scientist of Experimental Group Student With Code EGP28*

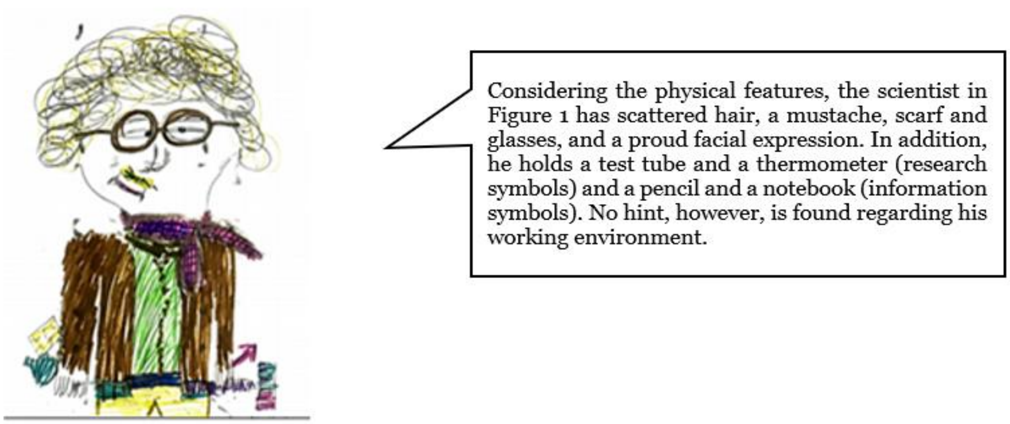


Figure 2. *Drawing of Scientist of Experimental Group Student With Code EGO19*

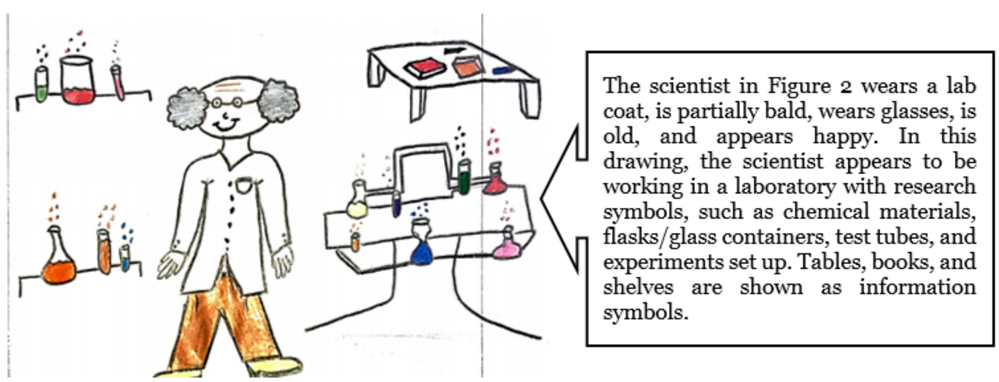


Figure 3. *Drawing of Scientist of Experimental Group Student With Code CGP12*

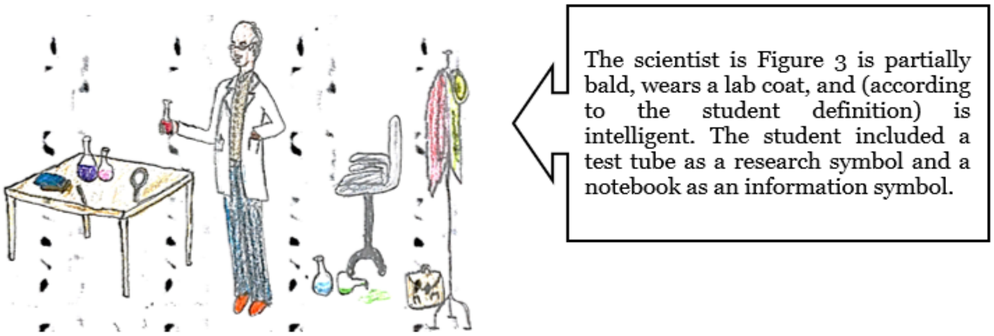
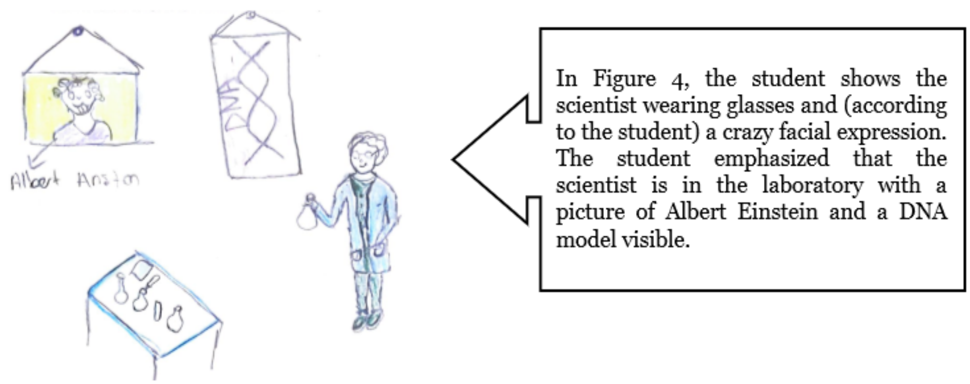


Figure 4. *Drawing of Scientist of Experimental Group Student With Code CGO15*



Symbols

Students' scientist drawings were also examined according to two different themes in terms of symbols. Frequency and percentage values of the pretest and posttest drawings of the experiment and control groups related to the symbols are shown in Table 2.

Table 2. *Frequency and Percentage Values Regarding Symbols*

Theme	Category	Experimental group				Control Group			
		Pretest		Posttest		Pretest		Posttest	
		f[a]	%[b]	*f*	%	*f*	%	*f*	%
Research symbols	Chemical material	6	16.7	9	21.4	11	24.4	10	22.7
	Flask/glass containers	6	16.7	9	21.4	14	31.2	14	31.8
	Test tube	8	22.2	6	14.3	8	17.8	10	22.7
	Unspecified	6	16.7	8	19	0	0	2	4.6
	Magnifying glass	3	8.2	1	2.4	1	2.2	3	6.8
	Bulb/lamp/headlamp	2	5.5	1	2.4	2	4.5	0	0
	Measuring instrument/ thermometer	1	2.8	2	4.8	0	0	0	0
	Gloves/cap	0	0	3	7.1	0	0	0	0

	Experiment glasses	1	2.8	1	2.4	1	2.2	0	0
	Assembly/experiment setup	1	2.8	1	2.4	4	8.9	4	9.1
	Flower	1	2.8	0	0	1	2.2	0	0
	Alcohol stove	0	0	0	0	1	2.2	0	0
	Stethoscope	0	0	0	0	1	2.2	0	0
	Microphone	1	2.8	0	0	0	0	0	0
	Guinea pig	0	0	0	0	1	2.2	1	2.3
	Experiment tong	0	0	1	2.4	0	0	0	0
Knowledge symbols	Table/shelf	10	38.5	10	32.3	16	34.7	15	34.0
	Unspecified	7	26.9	7	22.6	1	2.2	0	0
	Encyclopedia/books/ notebook	5	19.2	6	19.3	6	13.0	4	9.1
	Paper/pencil	2	7.7	2	6.5	2	4.4	3	6.8
	Library/file cabinet	2	7.7	2	6.5	5	10.8	5	11.3
	Formula/action	0	0	1	3.2	2	4.4	2	4.6
	Chart	0	0	1	3.2	2	4.4	1	2.3
	Note papers	0	0	0	0	5	10.8	4	9.1
	Writing board	0	0	1	3.2	3	6.5	3	6.8
	Model	0	0	0	0	0	0	4	9.1
	Technological products	0	0	0	0	2	4.4	1	2.3
	Chair	0	0	0	0	2	4.4	2	4.6
	Desk clock	0	0	1	3.2	0	0	0	0

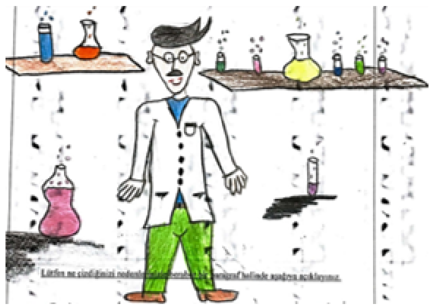
Note:
[a]*f* is the frequency of the student drawing these properties. The student may have stated more than one drawing feature, explanation, or opinion.
[b]*%* is the frequency percentage of students drawing these properties.

When examining the drawings of the students, the research symbols used in the pretest and posttest drawings increased in the experimental group (pretest f = 36, posttest f = 42), and they did not change significantly in the control group (pretest f = 45, posttest f = 44). In addition, the most common chemical materials—flask/glass containers and test tubes—were used in the pretest and posttest drawings of both groups. The explanations on the drawings also support these findings. EGP22 expressed, “He has a magnifying glass and some chemicals to make sure he’s a scientist” and EGO33 said, “The reason why I made these test tubes is that there cannot be a scientist without a test tube. I made both a test tube and a scientist next to it.”

In terms of information symbols, the control group used them more frequently than the experiment group in the pretest and posttest drawings. However, an increase in the frequency of drawing of the information symbols from the pretest to the posttest (pretest f = 26, posttest f = 31) showed no significant change in the control group (pretest f = 46, posttest f = 44). The most commonly used information symbols in both groups were a desk/shelf, an encyclopedia/book/notebook paper/pencil, and a library/filing cabinet. The students’ drawings were described as follows: “I drew a scientist and there is a table, a book on the table, and a light. This scientist reads books every evening” (EGO21), and “I think that the necessary materials are clocks to tell the time. I think they [the scientists] should have a pen in their pockets because they need it when they write an article” (EGO27). Although they are included in the pretests of the experimental group, the symbols of formula/operation (f = 1), table (f = 1), blackboard (f = 1) and table clock (f = 1) are included in the posttest drawings.

Examples of the drawings of the experiment and control group students’ symbols used in the test are presented below.

Figure 5. *Drawing of Scientist of Experimental Group Student With Code EGP19*



In Figure 5, the student included chemical materials, flasks/glass vessels, and test tubes as research symbols. The student also shows that the scientist works in a laboratory, wears a lab coat, and wears glasses; his hair is well groomed, and he has a mustache.

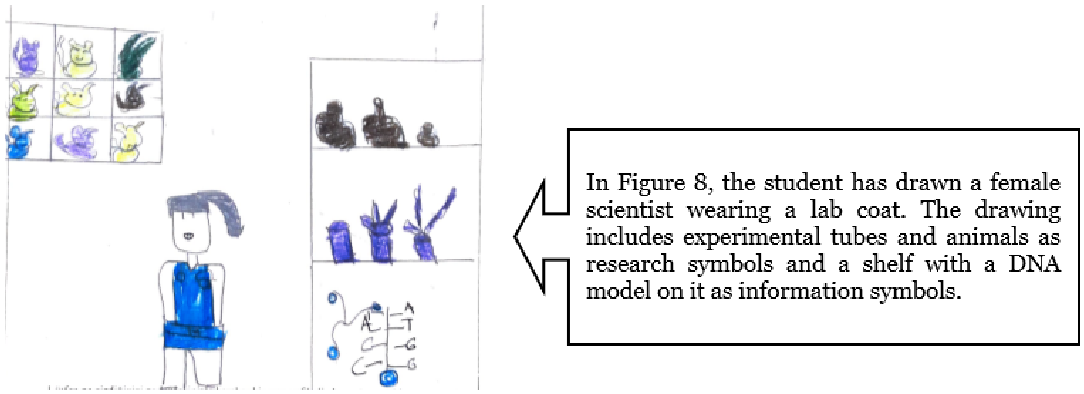
Figure 6. *Drawing of Scientist of Experimental Group Student With Code EGO33*

The student who drew Figure 6 included chemical materials and flasks/glass containers as research symbols. There are more information symbols shown in Figure 6, including a table, library, book/encyclopedia, blackboard, and a formula/process. The male scientist in Figure 6 has scattered hair, wears glasses, and has an unhappy facial expression. He appears to work in a laboratory.

Figure 7. *Drawing of Scientist of Experimental Group Student With Code CGP5*

In Figure 7, the student drew a female scientist wearing glasses. The scientist has a test tube and chemical flasks as research symbols. Also shown in the laboratory are notes, papers, books, and a shelf and table as information symbols.

Figure 8. *Drawing of Scientist of Experimental Group Student With Code CGO16*



Working Environment and Working Method/Style?

The students' drawings of scientists were further examined according to the two themes—working environment and working method/style. Table 3 shows the pretest and posttest frequency and percentage values of the drawing features of the experimental and control group students related to science working environment and working method/style.

Table 3. *Pretest and Posttest Frequency and Percentage Values for Working Environment and Working Method/Style*

Theme	Category-Subcategory	Experimental group				Control group			
		Pretest		Posttest		Pretest		Posttest	
		f[a]	%[b]	f	%	f	%	f	%
Working Environment	Uncertain	9	50	6	33.3	5	27.8	1	5.6
	Indoor environment—other	5	27.8	6	33.3	2	11.1	8	44.4
	laboratory space	4	22.2	5	27.8	11	61.1	9	50
	Outdoor environment–other laboratory space	0	0	1	5.6	0	0	0	0
Working Method	Does nothing	9	50	11	61.1	11	64.7	9	50.0
	Makes experiments	5	27.8	6	33.3	6	35.3	9	50.0
	Makes research	3	16.7	1	5.6	0	0	0	0
	Makes speech	1	5.5	0	0	0	0	0	0

Note:
[a]*f* is the frequency of the student drawing these properties. The student may have stated more than one drawing feature, explanation, or opinion.
[b]% is the frequency percentage of students drawing these properties.

The working environment of the students' drawings of scientists was examined in three different categories: uncertain, indoor, and outdoor. Though absent in the pretests of the experimental group, a drawing referring to the external environment (space $f = 1$) was found in the posttests. However, in the pretests and posttests of the control group, no drawing with an outside environment was found. In the control group, the most striking environment feature in both the pretests and posttests was the laboratory environment (pretest $f = 11$, posttest *f* = 9). The students who drew the scientists in closed environments explained the situation as follows: “The bookcase I built in his house is inside the man’s workshop. Since people used to be poor, there is not much in their workshops” (EGO36), and “I drew a scientist’s room. Because a scientist must have a room to work quietly” (CGP18). The only student who drew the working environment outdoors explained, “I drew a professor man (outside the World). Because this professor may produce something that nobody knows in the future, and maybe can create another world and take us there” (EGO31).

When the drawings were evaluated for working style, the working styles in the experimental group varied according to the control group. We can say that both groups concentrated on the way of working as experimenting. In student explanations regarding this situation, they said, “I made an experimental tube with the scientist. Because I have shown that he goes there to experiment” (EGO24), “Gregor Mendel is the scientist who tries to investigate similar and different aspects of people. Inheritance, for example; this man did an experiment on peas”(EGP27), and “I drew this scientist while doing the experiment. This scientist is trying to find a cure for tuberculosis” (CGO11).

Examples from the drawings of the experimental and control group students regarding the working environment and working method/style are presented below.

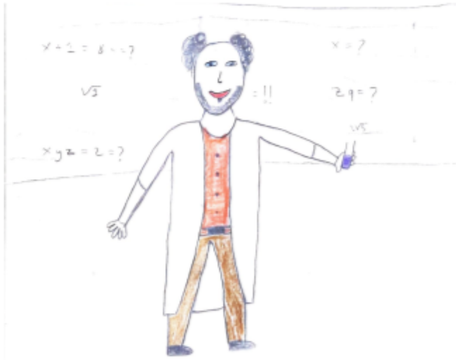
Figure 9. *Drawing of Scientist of Experimental Group Student With Code EGO31*

In Figure 9, the student drew the scientist as a professor working in space. The scientist has straight hair and appears to be engaged in no activity.

Figure 10. *Drawing of Scientist of Experimental Group Student With Code EGO29*

In Figure 10, the student drew a young scientist with well-groomed hair, wearing a lab coat, and showing a happy facial expression. This drawing shows the scientist using chemical materials, flasks/glass containers, and test tubes as research symbols.

Figure 11. *Drawing of Scientist of Experimental Group Student With Code CGO3*



In Figure 11, the student has shown the scientist wearing a lab coat. The scientist holds a test tube and there are formulae/operations marked on the board behind the scientist. The student remarked that the scientist has invented something and is happy with his invention.

Figure 12. *Drawing of Scientist of Experimental Group Student With Code CGP3*

In Figure 12, the student has drawn a male scientist surrounded by research symbols, including test tubes and chemicals. The student stated that the scientist is always working on inventions.

Results Related to Opinion Forms and Interviews

The findings obtained from the opinion forms and semistructured interviews are given in Table 4.

Table 4. *Findings About an Opinion Form and Semistructured Interviews*

Theme/ Category	Codes	f[a]	%[b]	Sample Student Comments
Yes	Change in thought	2	13.2	Yes, I learned their difficulty. For example (in the scenarios), when he [the scientist] produces a product, he remains in a dilemma when he thinks emotionally and has a hard time. Indecision is hard work (EG19). Yes, I would like to be like Mr. R. For example, we import banana from foreign countries. In other words, I would contribute to the economy of the country by making a living thing's gene instead of buying it with money (EG27). Yes, because I thought that they came together with nice acids to find a treatment method or made GMO products. But it turns out that they planned everything in advance (EG28).
	Understanding the difficulty of processes	1	6.7	
	Create a desire to make people happy	1	6.7	
	Contributing to the country's economy	1	6.7	
	Seeing the scientist working planned	1	6.7	
	Getting to know new scientists	1	6.7	
	Seeing topics are interesting	1	6.7	

No	No perception change	5	33.2	No, he did not. I always think of scientists who have had their hair electrocuted because of making inventions and experiencing explosion (EG23).
	Seeing the effort to facilitate human life	1	6.7	No. I don't think it changed my perception (EG25).
	Expressing the scientist's profile in a similar way	1	6.7	In fact, it has not changed much. I agree with what scientists actually do. Because they do what they do to make human life easier (EG22).

Note:
[a]*f* is the frequency of the student drawing these properties. The student may have stated more than one drawing feature, explanation, or opinion.
[b]*%* is the frequency percentage of student drawing these properties.

All of the answers given by the experimental group students were almost equal between "Yes" (*f* = 8) and "No" (*f* = 7). Students who gave a positive opinion that the teaching of the course with scientific scenarios changed their perceptions of scientists made similar statements both on the opinion forms and in the semistructured interviews. EG28 expresses his thoughts as,

> Yes. Actually, it is a little bit weird, but it seems to me as if they were doing experiments. It is as if they were finding something by themselves, but in fact, all of them had a reason. In other words, how do I say this, by thinking that we will pour this here and it will be like this … . For example, these are the things that genetic engineers do in biotechnology in DNA … . Why did they go and remove the gene of the ice fish and put it in a strawberry, for example. Why they did not go and put the gene of the giraffe [in a strawberry]? So I thought he [the scientist] had done it by himself by trying several times, but it turned out that they all had a purpose.

EG19 explained his opinion about his change in the perceptions of scientist with the following words:

> In fact, it changed a lot. I also had the desire to play like this with genes. And when it comes to scientists, different things happened in our minds. We learned everything about their difficulties and entertainment. I think they have been in a dilemma. For example, when placing (products) on the market, people try them on animals for their positive and negative aspects. There was one scenario about it in the course. One of the mice there was allergic. Our teacher asked whether the scientist would put the strawberry on the market or not. We were also in a dilemma, so I think that would be a very difficult dilemma for them.

Written opinions (*f* = 7) on the fact that the practices do not change the perceptions of the scientists are supported in one-to-one interviews. From EG32's point of view,

> I don't think it changed much. In this context, I would actually perceive scientists badly by using people … . So for example, cloning … . If they do it on people, they can have bad effects. They did it on animals, some animals got contagious diseases. But it's still good because they don't do it on humans. Some of them can do it on humans, so my opinion is still the same.

In the context of this statement, the student's idea did not change after the applications because the student believed that scientists have the potential to abuse scientific knowledge.

Discussion

According to the data obtained from the Draw-a-Scientist Test and student explanations, the perceptions of students toward the image of the scientist varied. Accordingly, students indicated that scientists do not have time to take care of their hair because they perceive that time is very valuable for scientists. Similar studies are included in the literature on the students' drawings with messy hair (Balçın & Ergün, 2018; Bernard & Dudek, 2017; Chambers, 1983; Christidou et al., 2016; McCarthy, 2015; Ferguson & Lezotte, 2020; Lamminpää et al., 2020; Meyer et al., 2019). In addition, the students included the bald/partially shed hair in their drawings of scientists because they believe the scientists are working hard in a stressful working environment. There are also studies in the literature where students drew the scientist bald or without hair (Balçın & Ergün, 2018; Bozzato et al., 2021; Christidou et al., 2016; Meyer et al., 2019). Students in this research had the opinion that scientists who were bald, those without hair, or those with curly hair had an intelligent appearance.

When the drawings of scientists were examined in terms of clothing and accessory features, daily/sportswear clothing was in both the experimental and control groups' drawings in the pretests and posttests, and glasses and lab coats were the most common accessories used in the drawings. The students had the idea that people with glasses were smart, that the scientists thought that the colors would make a difference in the clothing characteristics, and that they reflect them as a personal feature. In line with the explanations of the students' drawings, the lab coat is accepted as an indicator of rigor and order, and it is described as an outfit that protects the scientists during experimental activities. In many studies in the literature, glasses (Bozzato et al., 2021; Emvalotis & Koutsianou, 2018; Gormally & Inghram, 2021; Hagenkötter et al., 2021; Leavy & Hourigan, 2021; Meyer et al., 2019; Miller et al., 2018; Reinisch et al., 2017) and a lab coat (Gormally & Inghram, 2021; Hagenkötter et al., 2021; Leavy & Hourigan, 2021; Miller et al., 2018; McCarthy, 2015; Shimwell et al., 2021; Thomson et al., 2019) are among the accessories used by the scientists. In the use of such figures, the students made stereotyped drawings because they are influenced by media sources, such as films, magazines, or television (Tan et al., 2015; Türkmen, 2008). Similarly, students are influenced by the visual and verbal components in the media and textbooks while forming their perceptions of scientists and, therefore, they create stereotyped and change-resistant ideas (Farland-Smith et al., 2017; Ferguson & Lezotte, 2020).

When the drawings of scientists were analyzed in terms of facial expression, happy facial expressions in the drawings were higher in both the experimental and control groups. Similarly, there are studies in the literature that conclude that students create happy facial expressions in drawings of scientists (Lamminpää et al., 2020; Leavy & Hourigan, 2021; McCarthy, 2015). In this case, students perceive the scientists as people who are happy with their work. In addition, there were a few drawings in the posttests of both experimental and control groups of scientists expressing a mad facial expression. In the literature, students' drawings of scientists also included crazy facial expressions (Farland-Smith et al., 2017; Ferguson & Lezotte, 2020), with sinister and strange expressions (Bozzato et al., 2021; Nguyen & Riegle-Crumb, 2021), angry-frowning expressions (Christidou et al., 2021; Farland-Smith et al., 2017; Ferguson & Lezotte, 2020), and neither happy nor unhappy expressions (El Takach & Yacoubian, 2020; El Takach, 2018; Thomson et al., 2019). Hagenkötter et al. (2021) and Thomson et al. (2019) determined that crazy and strange expressive drawings were generally similar to Albert Einstein. In the current study, some students tried to compare their drawings to famous scientists and, in their explanations, they gave information about who they are. However, the number of students referring to Gregor Johann Mendel, who conducted heredity studies related to the DNA and genetic code unit, was quite low.

When the research symbols used by the students in their drawings were examined, the most commonly used symbols were test tubes, chemical materials, and flasks/glasses. The students' explanations were that the test tubes and flasks/glasses are indispensable materials for scientists. Similarly, in the literature, students usually use laboratory materials such as test tubes, glassware, glass containers/bottles, and magnifiers (Bernard & Dudek, 2017; Christidou et al., 2021; Emvalotis & Koutsianou, 2018; Lamminpää et al., 2020; Leavy &

Hourigan, 2021; McCarthy, 2015; Meyer et al., 2019; Reinisch et al., 2017; Thomson et al., 2019). In the students' drawings, such laboratory materials are used because they think that scientists generally work in a laboratory environment. In our study, which is based on scientific scenarios, students described the scientist as an individual who makes inventions/discoveries, does research, performs experiments, and mixes potions; this was evident both in their drawings and in the explanations for the drawings.

Various information symbols were used by the students in their drawings for our study. Students drew tables/shelves, pens, file cabinets/bookshelves, astronomical visuals, writing boards, paper, notebooks, DNA models, and mathematical signs. In the literature, middle school students drew various similar information symbols, such as books, pens, tables, cupboards, chairs, boards, blackboards, and models related to the subject (Bozzato et al., 2021; Clark et al., 2021; El Takach & Yacoubian, 2020; Leavy & Hourigan, 2021; Meyer et al., 2019; McCarthy, 2015; Thomson et al., 2019). In addition, the drawing of the DNA model was not found in the pretest drawings of the control group students but was included in the posttest drawings. However, despite the application of scientific scenarios and activities about DNA, the DNA model was not included in the drawings of the experimental group students. The reason for this is that the experimental group students perceived that activities related to DNA can be easy in the classroom and that scientists are working with more difficult efforts. Therefore, these students, who have stereotypical perception of scientists, did not include the DNA model in their drawings since they have the idea that the working environment of scientists should be in a different environment than the classroom or that an invention/discovery should be made.

According to the data obtained from the drawings and explanations made by the students, the scientist generally worked in the laboratory and in closed areas, such as the study room. Students in other studies perceived the scientist as someone who works indoors (Clark et al., 2021; Leavy & Hourigan, 2021). Similarly, different studies in the literature revealed that students draw scientists as individuals working in closed spaces and in the laboratory (Bernard & Dudek, 2017; Christidou et al., 2016; Emvalotis & Koutsianou, 2018; Farland-Smith et al., 2017; Ferguson & Lezotte, 2020; Kang et al., 2019; Leavy & Hourigan, 2021; McCann & Marek, 2016; Meyer et al., 2019; Miller et al., 2018; Thomson et al., 2019). Although working methods such as research, experiment, and invention/discovery can be produced in a laboratory environment, students did not grasp that everywhere is a laboratory, a fact that can be ignored by students and even society as a whole.

Implications for Theory and Practice

In our study, the change in the students' perceptions of scientists from scenario-based learning was taken into consideration. From the data obtained on the opinion forms and from semistructured interviews, students who gave a positive opinion of the scientific scenarios changed their perceptions of scientists. The results indicated that the students understood the difficulty of the processes experienced by the scientists, realized that they contributed to their country's economy, and recognized that they were working in a planned manner. Students also had the chance to meet a new scientist. The students changed their stereotyped perception of scientists as individuals who make inventions/discoveries, perform experiments, and mix potions and explained this by giving examples about the unit in which scientific scenarios were handled. Students realized that scientists may have difficulties, that they produce ideas for the benefit of all humanity in their studies, and that they work systematically (by applying scientific research steps) with a plan and program. Some students described themselves as future scientists. Therefore, we can say that the use of scientific scenarios in science classes has positive effects on those students' perceptions of scientists. Ultimately, scenario-based teaching yielded effective and productive results on students' perceptions of scientists. In this context, scenario-based texts and pictures that give life stories of scientists from different cultures should be included in science textbooks. In addition, it is important to take measures that will require all visual and written media sources to be sensitive about the issue. Science teacher candidates and teachers working in science should also be equipped with the ability to create scientific scenarios and use them in the classroom. It is important, therefore, to conduct further studies examining the effect of scenario-based learning on variables related to other higher-level thinking skills that positively affect eighth-grade students' perceptions of scientists.

References

Ateş, Ö., Ateş, A. M., & Aladağ, Y. (2021). Perceptions of students and teachers participating in a science festival regarding science and scientists. *Research in Science & Technological Education, 39*(1), 109–130. https://doi.org/10.1080/02635143.2020.1740666

Balçın, M. D., & Ergün, A. (2018). Secondary school students' perceptions and attitudes about scientists. *European Journal of Education Studies, 4*(4), 66–93. https://doi.org/10.5281/zenodo. 1206989

Bell, S., & Page, R. (2003). *Development of scenario based learning*. Dunmore Press.

Bernard, P., & Dudek-Różycki, K. (2017). Revisiting students' perceptions of research scientists—outcomes of an indirect Draw-a-Scientist Test (InDAST). *Journal of Baltic Science Education, 16*(4), 562–575. http://oaji.net/articles/2017/987-1503905214.pdf

Bozzato, P., Fabris, M. A,. & Longobardi, C. (2021). Gender, stereotypes and grade level in the Draw-a-Scientist Test in Italian schoolchildren. *International Journal of Science Education, 43*(16), 2640–2662. https://doi.org/10.1080/09500693.2021.1982062

Chambers, D. W. (1983). Stereotypic images of the scientist: The Draw-a-Scientist Test. *Science Education*, *67*(2), 255–265. https://doi.org/10.1002/sce.3730670213

Chang, H-Y., Lin, T-J., Lee, M-H., Lee, S. W-Y., Lin, T-C., Tan, A-L., & Tsai, C-C. (2020). A systematic review of trends and findings in research employing drawing assessment in science education. *Studies in Science Education*, *56*(1), 77–110. https://doi.org/10.1080/03057267.2020.1735822

Chermack, T. J., & Merwe, L. (2003). The role of constructivist learning in scenario planning. *Futures*, 35, 445–460. https://doi.org/10.1016/S0016-3287(02)00091-5

Christidou, V., Bonoti, F., & Hatzinikita, V. (2021). Drawing a scientist: Using the Emo-DAST to explore emotional aspects of children's images of scientists. *Research in Science & Technological Education*. https://doi.org/10.1080/02635143.2021.1998770

Christidou, V., Bonoti, F., & Kontopoulou, A. (2016). American and Greek children's visual images of scientists: Enduring or fading stereotypes? *Science & Education, 25*(5–6), 497–522. https://doi.org/10.1007/s11191-016-9832-8

Christidou, V., & Kouvatas, A. (2011). Visual self-images of scientists and science in Greece. *Public Understanding of Science*, *22*(1), 91–109. https://doi.org/10.1177/0963662510397118

Clark, S. K., Lott, K., Larese-Casanova, M., Taggart, A. M., & Judd, E. (2021). Leveraging integrated science and disciplinary literacy instruction to teach first graders to write like scientists and to explore their perceptions of scientists. *Research in Science Education*, *51,* 1153–1175. https://doi.org/10.1007/s11165-020-09927-9

Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education* (8th ed.). Routledge Falmer.

Çubukçu, Z. (2012). Senaryo tabanlı öğrenme Scenario based learning [Senaryo tabanlı öğrenme]. In S. F. Büyükalan (Ed.), *Öğrenme öğretme kuram ve yaklaşımları [Learning teaching theories and approaches]* (pp. 551–557). Pegem Academy.

Deniş, Ç. H., & Erduran Avcı, D. (2015). Scientist perception of primary school students: How does attendance to scientific activities affect scientist perception? *Mehmet Akif Ersoy University Journal of Education Faculty, 1*(36), 90–104. https://dergipark.org.tr/tr/pub/maeuefd/issue/19409/206408

El Takach, S. (2018). How do early childhood education pre-service teachers view science and scientists? *The Eurasia Proceedings of Educational and Social Sciences, 9,* 104–119. https://dergipark.org.tr/tr/pub/epess/issue/38900/457749

El Takach, S., & Yacoubian, H. A. (2020). Science teachers' and their students' perceptions of science and scientists. *International Journal of Education in Mathematics, Science and Technology (IJEMST)*, *8*(1), 65–75.

Emvalotis, A., & Koutsianou, A. (2018). Greek primary school students' images of scientists and their work: Has anything changed? *Research in Science & Technological Education, 36*(1), 69–85. https://doi.org/10.1080/02635143.2017.1366899

Farland-Smith, D., Finson, K. D., & Arquette, C. M. (2017). How picture books on the National Science Teacher's Association recommend list portray scientists. *School Science and Mathematics, 117*(6), 250–258. https://doi.org/10.1111/ssm.12231

Farland-Smith, D., Finson, K., Boone, W., & Yale, M. (2010). Investigating the sources of images students hold about scientists through application of Rasch analysis. Paper presented at the 2010 *Annual International Conference of the Association for Science Teacher Education (ASTE),* Sacramento, CA.

Ferguson, S. L., & Lezotte, S. M. (2020). Exploring the state of science stereotypes: Systematic review and meta-analysis of the Draw-a-Scientist checklist. *School Science and Mathematics, 120*(1), 55–65. https://doi.org/10.1111/ssm.12382

Finson, K. D., Beaver, J. B., & Cramond, B. L. (1995). Development of and field test of a checklist for the Draw-a-Scientist Test. *School Science and Mathematics*, *95(*4), 195–205. https://doi.org/10.1111/j.1949-8594.1995.tb15762.x

Fiorella, L., & Zhang, Q. (2018). Drawing boundary conditions for learning by drawing. *Educational Psychology Review, 30*(3), 1115–1137. https://doi.org/10.1007/s10648-018-9444-8

Gandolfi, H. E. (2018). Different people in different places. *Science & Education, 27*, 259–297. https://doi.org/10.1007/s11191-018-9971-1

Gormally, C., & Inghram, R. (2021). Goggles and white lab coats: Students' perspectives on scientists and the continued need to challenge stereotypes. *Journal of Microbiology & Biology Education, 22*(1), 1–11. https://doi.org/10.1128/jmbe.v22i1.2273

Hagenkötter, R., Nachtigall, V., Rolka, K., & Rummel, N. (2021). "Meistens sind forscher älter, meist tragen die eine brille"—Schülervorstellungen über wissenschaftler*innen. ["Most researchers are older—usually they wear glasses"—Pupils' ideas about scientists]. *Unterrichtswiss [Educational Science], 49*, 603–626. https://doi.org/10.1007/s42010-021-00110-1

Heitger, R. A., & Milner, A. R. (2017). Trusting STEM experts and authorities in the age of "fake news." *School Science and Mathematics, 117*(3–4), 89–91. https://doi.org/10.1111/ssm.12216

Hite, R. L., & White, J. (2022). Hispanic elementary students' improved perceptions of science and scientists upon participation in an environmental science afterschool club. *Applied Environmental Education & Communication, 21*(1), 73–86. https://doi.org/10.1080/1533015X.2021.1986431

Kang, H., Calabrese Barton, A., Tan, E., Simpkins, S. D., Rhee, H-Y., & Turner, C. (2019). How do middle school girls of color develop STEM identities? Middle school girls' participation in science activities and identification with STEM careers. *Science Education, 103*(2), 418–439. https://doi.org/10.1002/sce.21492

Lamminpää, J., Vesterinen, V-M., & Puutio, K. (2023). Draw-a-science-comic: Exploring children's conceptions by drawing a comic about science. *Research in Science & Technological Education*, *41* (1), 39–60. https://doi.org/10.1080/02635143.2020.1839405

Leavy, A., & Hourigan, M. (2021). "The green potion is the virus. The blue one is the corona test. The coloured one makes your wish come true": Irish children's changing perceptions of a scientist as a result of the onset of COVID-19. *Irish Educational Studies, 40*(2), 407–418. https://doi.org/10.1080/03323315.2021.1915845

Lei, R. F., Green, E. R., Leslie, S.-J., & Rhodes, M. (2019). Children lose confidence in their potential to "be scientists," but not in their capacity to "do science." *Developmental Science, 22*(6), e12837. https://doi.org/10.1111/desc.12837

McCann, F. F., & Marek, E. A. (2016). Achieving diversity in STEM: The role of drawing-based instruments. *Creative Education, 7*(15), 2293–2304. https://doi.org/10.4236/ce.2016.715223

McCarthy, D. (2015). Teacher candidates' perceptions of scientists: Images and attributes. *Educational Review, 67*(4), 389–413. https://doi.org/10.1080/00131911.2014.974510

McMillan, J. H., & Schumacher, S. (2010). *Research in Education: Evidence-Based Inquiry* (7th ed.). Pearson.

Mead, M., & Metraux, R. (1957). Image of the scientist among high-school students. *Science, 126*, 384–390. www.jstor.org/stable/1752140

Medina-Jerez, W., Middleton, K. V., & Orihuela-Rabaza, W. (2011). Using the DAST-C to explore Colombian and Bolivian students' images of scientists. *International Journal of Science and Mathematics Education, 9*, 657–690. https://doi.org/10.1007/s10763-010-9218-3

Mergoupi-Savaidou, E., Papanelopoulou, F., & Tzokas, S. (2012). Science and technology in Greek newspapers, 1900–1910. Historiographical reflections and the role of journalists for the public images of science and technology. *Science & Education, 21*, 293–310. https://doi.org/10.1007/s11191-010-9292-5

Meyer, C., Guenther, L., & Joubert, M. (2019). The Draw-a-Scientist Test in an African context: Comparing students' (stereotypical) images of scientists across university faculties. *Research in Science & Technological Education, 37*(1), 1–14. https://doi.org/10.1080/02635143.2018.1447455

Miles, M. B., Huberman, A. M., & Saldana, J. (2019). *Qualitative data analysis: A methods sourcebook*, (4th ed.) Sage Publications.

Miller, D. I., Nolla, K. M., Eagly, A. H., & Uttal, D. H. (2018). The development of children's gender-science stereotypes: A meta-analysis of 5 decades of U.S. Draw-a-Scientist studies. *Child Development, 89*(6), 1943–1955. https://doi.org/10.1111/cdev.13039

Nguyen, U., & Riegle-Crumb, C. (2021). Who is a scientist? The relationship between counter-stereotypical beliefs about scientists and the STEM major intentions of Black and Latinx male and female students. *International Journal of STEM Education, 8*(28), 1–18. https://doi.org/10.1186/s40594-021-00288-x

Owens, D. C., Petitt, D. N., Lally, D., & Forbes, C. T. (2020). Cultivating water literacy in STEM education: Undergraduates' socio-scientific reasoning about socio-hydrologic issues. *Water, 12*(10), 1–18. https://doi.org/10.3390/w12102857

Punch, K. F. (2005). *Introduction to social research: Quantitative and qualitative approaches,* 2nd ed. Sage Publications.

Reinisch, B., Krell, M., Hergert, S., Gogolin, S., & Krüger, D. (2017). Methodical challenges concerning the Draw-A-Scientist Test: A critical view about the assessment and evaluation of learners' conceptions of scientists. *International Journal of Science Education, 39*(14), 1952–1975. https://doi.org/10.1080/09500693.2017.1362712

Robinson, J. D., Berbari, N. F., & Rao, A. S. (2020). Using a student-generated mock magazine issue to improve students' awareness of diverse scientists. *Journal of Microbiology & Biology Education, 21*(3), 1–11. https://doi.org/10.1128/jmbe.v21i3.2233

Shimwell, J., DeWitt, J., Davenport, C., Padwick, A., Sanderson, J., & Strachan, R. (2021). Scientist of the week: Evaluating effects of a teacher-led STEM intervention to reduce stereotypical views of scientists in young children. *Research in Science & Technological Education, 41*(2), 423–443. https://doi.org/10.1080/02635143.2021.1941840

Takahashi, B., & Tandoc, E. C. (2016). Media sources, credibility, and perceptions of science: Learning about how people learn about science. *Public Understanding of Science*, *25*(6), 674–690. https://doi.org/10.1177/0963662515574986

Tan, A. L., Jocz, J. A., & Zhai, J. (2015). Spiderman and science: How students' perceptions of scientists are shaped by popular media. *Public Understanding of Science*, *26*(5), 520–530. https://doi.org/10.1177/0963662515615086

Taylor, J. A., Adams, C. T., Westbrook, A. L., Creasap Gee, J., Spybrook, J. K., Kowalski, S. M., Gardner, A. L., & Bloom, M. (2022). The effect of a student–teacher–scientist partnership program on high school students' science achievement and attitudes about scientists. *Journal of Research in Science Teaching, 59*(3), 423–457. https://doi.org/10.1002/tea.21733

Temur, D., & Turan, H. (2018). The effect of scenario-based learning approach on solving problems of addition and subtraction of third grade students of primary school. *Kocaeli University Journal of Education*, *1*(2), 72–84. https://doi.org/10.33400/kuje.451771

Thomson, M. M., Zakaria, Z., & Radut-Taciu, R. (2019). Perceptions of scientists and stereotypes through the eyes of young school children. *Education Research International,* 1–22. https://doi.org/10.1155/2019/6324704

Toma, R. B., Greca, I. M., & Orozco Gómez, M. L. (2018). Una revisión del protocolo Draw-a-Scientist Test (DAST) [review of the Draw-a-Scientist test (DAST) protocol. *Revista Eureka Sobre Enseñanza y Divulgación de Las Ciencias [Eureka Journal on Science Education and Dissemination] 15*(3), 1–19. https://doi.org/10.25267/Rev_Eureka_ensen_divulg_cienc.2018.v15.i3.3104

Türkmen, H. (2008). Turkish primary students' perceptions about scientist and what factors affecting the image of the scientists. *Eurasia Journal of Mathematics, Science & Technology Education, 4*(1), 55–61. https://doi.org/10.12973/ejmste/75306

Yacoubian, H. A., Al-Khatib, L., & Mardirossian, T. (2017). Analysis of the image of scientists portrayed in the Lebanese national science textbooks. *Science & Education*, *26*, 513–528. https://doi.org/10.1007/s11191-017-9908-0

Appendix A. Topic and Concept Content for the "DNA and Genetic Code" Unit

F.8.2.1. DNA and Genetic Code—(1. Subtopic that is the same as the name of the unit)

Subject/Concepts: Structure of DNA, self-replication of DNA, nucleotide, gene, chromosome

F.8.2.1.1. Explains the concepts of nucleotide, gene, DNA, and chromosome and establishes a relationship between these concepts.

F.8.2.1.2. Shows the structure of DNA on the model.

F.8.2.1.3. Expresses how DNA matches itself.

F.8.2.2. Heredity—(2nd subtopic of the unit)

Subject/Concepts: Gene, genotype, phenotype, pure progeny, hybrid progeny, dominant, recessive, cross, gender, consanguineous marriages

F.8.2.2.1. Defines the concepts related to heredity.

F.8.2.2.2. Comments on the results by solving problems with single character diagonals.

F.8.2.2.3. Discusses the genetic consequences of consanguineous marriages.

F.8.2.3. Mutation and modification—(3rd subtopic of the unit)

Subject/Concepts: Mutation, modification

F.8.2.3.1. Explains the mutation based on examples.

F.8.2.3.2. Describes the modification based on examples.

F.8.2.3.3. Makes inferences regarding the differences between mutation and modification.

F.8.2.4. Adaptation (adaptation to the environment)—(4th subtopic of the unit)

Subject/Concepts: Adaptation, natural selection, variation

F.8.2.4.1. Explains the adaptation of living things to the environment they live in by observing.

F.8.2.5. Biotechnology (5th subtopic of the unit)

Subject/Concepts: Genetic engineering, artificial selection, biotechnological studies, impact of biotechnology applications on the environment

F.8.2.5.1. Associates genetic engineering and biotechnology.

F.8.2.5.2. Discusses the useful and harmful aspects of these applications for humanity with the dilemmas created within the scope of biotechnological applications.

F.8.2.5.3. Predicts what future genetic engineering and biotechnology applications might be.

Note: A kind of code is used in sciences programs in the Ministry of Education of Turkey. If we take in consideration F.8.2.1. as example:

'F' shows that it is a science course,

'8' shows that it is the 8th grade level,

'2' shows that it is the second unit,

'1' shows that it is the subject number and that for each one, the number following represents the gain number.

Appendix B. Checklist for Evaluation of Student Drawings

Combined categories	Categories		Codes
Scientists' physical appearance	Clothing features (lab coat, suit, vest, etc.)	Yes No	If yes, which one(s):
	Accessories (glasses, necklace, badge, foulard, etc.)	Yes No	If yes, which one(s):
	Aesthetic appearance (shape of hair, beard, mustache, sideburns, etc.)	Yes No	If yes, which one(s):
	Scientist's facial expression (happy, unhappy, angry, thoughtful, crazy, etc.)	Yes No	If yes, which one(s):
	Age (young, old, etc.)	Yes No	If yes, which one(s):
	Other physical appearance (Simulated Scientist, etc.)	Yes No	If yes, which one(s):
Tools and sources of knowledge used by the scientists	Research equipment (experimental materials, test tube, flask, thermometer, flower, etc.)	Yes No	If yes, which one(s):
	Knowledge resources (note paper, desk clock, library, book, magazine, formula/action, etc.)	Yes No	If yes, which one(s):
Scientists' workplace	Environment in which the scientist conducts research (laboratory, home, garden, outdoor environment, indoor environment, etc.)	Yes No	If yes, which one(s)
How the scientists work	How the scientists work (experiment, think, teach, research, do nothing, etc.)	Yes No	If yes, which one(s):

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