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Research Article

Perceptions of Scientists and Stereotypes through the Eyes of Young School Children

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The goal of the current study was to investigate children's representations of scientists using the Draw-a-Scientist Test (DAST). Participants ($n = 210$) were young school children from Romania enrolled in both rural and urban public schools from grade levels 3, 4, and 5. The study findings showed that most children represented stereotypical characteristics of scientists in their drawings such as white male wearing lab coats using instruments that reflected a chemistry lab. Results also indicated statistically significant differences in the score of stereotyping indicators with respect to student grade level. Additionally, students who visited science museums scored significantly higher in stereotyping indicators than students who indicated on their survey answers that they have not visited science museums. Findings are discussed in relationship with students' views about scientists and their understanding of science.

1. Introduction

Students' early experiences with science are important for developing not just their STEM literacy, but also in influencing their perceptions of science and the work of scientists. How students understand science and the work of scientists is partly influenced by how this information is presented to them, inside and outside classrooms. Educational research and international reports focus lately on monitoring students' STEM achievements and career aspirations, as well as the composition of individuals pursuing STEM careers [1–5]. Research shows that at large, the makeup of STEM workforce is comprised of men; women and individuals identifying with a minority group are underrepresented in most science and technology fields [6, 7]. Identifying children's perceptions of scientists and their understanding of science is a first step in capturing the stereotypes they have about "who is a scientist," "who can go into science," and if they themselves "belong to a science career". Drawing is a very powerful way of measuring young children's understanding of the world around them as it reveals their cognitive schemas about how things work, the meaning of relationships, cultural norms, or behaviors. In studies investigating children's representations of scientists, drawings revealed their beliefs and stereotypes about scientists. Such beliefs can play a central role in shaping students' science interests and their identification with science careers [8].

The goal of the current study was to examine children's depictions of scientists from public schools in rural and urban areas in Romania. While research in this area has been conducted systematically in the US for instance, informing education about the early perceptions of scientists and public understanding of science, there are no studies to date examining children's stereotypes of scientists and domain identification from Romania. Contributions from this study can help understand some of the sociocultural factors that may influence children's perceptions of scientists and their understanding of science.

2. Students' Perceptions of Scientists

Recent studies emphasize the importance of investigating how students' perception of science and scientists has developed over time [9]. Students' perception of scientists may play an important role in developing their science interest and attitudes to science [10, 11]. This topic has been investigated for five decades, starting with Mead and Metraux's study [11], in which 35,000 high school students were asked to write essays about scientists. Their findings reported several stereotypical characteristics, which were supported by other studies later, i.e., [12–14]. From the time frame of 50s to 80s, most studies found stereotypical characteristics in the visual and descriptive images of scientists, such as scientists wearing lab coats and eyeglasses, working with tubes/bottles full of chemicals, and sometimes having a sinister or eccentric expression on their faces.

Chambers [15] developed and introduced the Draw-a-Scientist-Test (DAST) to collect information more elaborately about students' perceptions of scientists. In Chambers' study, students were given a blank paper and asked to draw a scientist. Afterwards, the drawings were coded per seven specific attributes. These attributes were lab coat, eyeglasses, facial growth of hair, symbols of research, symbols of knowledge, technology, and relevant captions. Studying data from 4,807 elementary students, Chambers found a standard image of the scientist which was in line with Mead and Metraux's [11] findings. Chamber's study [15] also found an alternative image of scientists where magical portrayals and fictional characters like Frankenstein were represented as scientists.

Recent studies using DAST investigated students' perception of scientists in different countries and cultures throughout several continents [16–21]. Almost all studies confirmed that students have a stereotypical view of scientists where scientists are mainly represented as white males wearing lab coats, eyeglasses, with facial hair, and an eccentric appearance [8, 15, 16, 22–24].

2.1. Stereotypes. Research shows that children and public at large hold stereotypes about scientists' image, the nature of their work, and what do they do [8, 19, 23, 25, 26]. Findings from US studies for instance, where most of the DAST research has been conducted, have shown that scientists were depicted as individuals serving greedy corporations, playing God, tempering with nature, and misusing technology [27]. Other stereotypes were related to scientists' gender and ethnicity. Scientists at large were depicted by children as white males; Hispanic and Asian scientists were underrepresented. Female scientists were occasionally represented, and most of the time depicted as "superwomen" [28].

2.1.1. Gender Stereotypes. White male scientists have dominated students' depictions of scientists for almost five decades [15, 23, 29–31]. Male scientists were depicted by both male and female students; the few female scientists were mostly represented by female students [22, 32–34]. Many studies, including a meta-analysis on 78 studies [9] found that only about half or even less female students draw female scientists [15, 29, 32, 35]. Miller et al. [9, 36] in their meta-analysis study showed that children's representations of scientists have changed over time; they drew male scientists less often in recent years compared to earlier decades. Findings show that children drew 99.4% scientists as males in Chambers' study [15] compared to 72% in studies conducted later (e.g., from 1985–2016).

2.1.2. Stereotypes in Scientist's Specialty. In the history of DAST studies, stereotyping scientists as professionals working in chemistry laboratories are quite prominent. Chambers [15] explained how stories of alchemy have made the professional of chemist popular among artists. The majority of studies in which DAST was used to explore students' perception of scientist revealed that students depict predominantly scientists as chemists [18, 23].

2.1.3. Influences in Stereotyping. Most common factors influencing students' perceptions are media, children's literature, or students' lack of exposure to scientists' work. Several studies found that media represent a major influential source in reinforcing the gender roles and gender stereotypes in professions [22, 35, 37]. In order to change this stereotypic trend, several experimental interventions have been implemented, such as media literacy programs [31], teacher intervention programs [38, 39], teaching strategy reform initiatives, visiting scientists' programs [40], and science camps [41]. These were a few initiatives and interventions that showed a positive effect in changing students' perceptions about scientists.

2.2. Current Study. The current study aimed at investigating young students' representations of scientists. Participants ($n = 210$) were students in grades 3, 4, and 5 from rural and urban public schools in Romania and ranged in age (mean of 10 years old). Participants were recruited from six different public schools. Among them, four schools were in rural settings, and two schools were in urban settings. Studies on this topic have been conducted in the US and Western European countries (i.e., the UK); however, there is a lack of research in this field in Eastern Europe, especially in Romania.

Only one study was identified in the literature [18] exploring European children's perceptions of scientists which included participants from Romania ($n = 170$), among other European countries. Our study included a larger number of participants ($n = 210$) compared to Rodari's study [18]. Additionally, all participants in our study were from Romania, from schools located predominantly in central Romania, and northwestern regions of Romania, regions that are diverse ethnically (i.e., Romanian, Hungarian, Ukrainian, and Roma), thus capturing a cultural diversity, but also a diversity specific to certain settings (e.g., urban and rural). Moreover, our study focuses on capturing young school children's depictions of scientists, students from different grade levels (i.e., 3rd, 4th and 5th grade), and aged between 9 and 12 years old, whereas Rodari's study [18] included students aged 9 years old only (grade level 2nd or 3rd) and students aged 14 years old only (grade level 7th or 8th). As other studies pointed out [8, 18], drawings provide powerful information up to the age of 10–12, as children's language skills and written communication are still developing at this age. After the age of 12, most students cease to draw and can better communicate in writing or orally [8].

2.3. Research Questions. The main research questions addressed by the current study were as follows:

(1) What do students' drawings reveal with respect to scientists' (a) appearance, (b) specialty, and (c) gender?

(2) In what ways do student characteristics, such as ethnic membership, religion, school location (i.e., rural versus urban), gender, grade level, and age, influence their perceptions and stereotyping of scientists?

(3) In what ways does access to scientific and educational places, such as (a) science laboratories and (b) science museums, influence children's perceptions and stereotyping of scientists?

3. The Educational Context

The K-12 educational system in Romania has been reformed for the past 25 years, and reform continues; however, student learning outcomes, as shown in recent European reports [2], need significant improvement. STEM education at the elementary level is not a priority in Romania; the majority of schools are struggling to tackle student enrollment and increase attendance. Yet, Romanian students at all levels are expected to meet high global standards in literacy, mathematics, and science despite the scarcity of STEM learning experiences and resources for all students.

Recent educational reports [2] show that Romania ranked poorly on several key education indicators, such as school enrollment, science and mathematics literacy, and graduation rates compared to other European Union (EU) countries. For instance, Romania ranks last on elementary education enrollment (85.8% enrollment compared to about 90% enrollment in other EU countries). The participation rates in elementary education in Romania have declined by 7% in the last decade, which is the largest drop in the EU.

Additional results from international assessments, such as the Progress of International Student Assessment (PISA), place Romania at the bottom in terms of academic achievement in science, mathematics, and literacy [2]. Romania has the *highest low-achieving rate in science literacy* compared to other EU countries; about 37% of students were classified as low achievers in science. Additionally, Romania is second to last on low achievers in reading literacy (37%) and mathematics (41%) compared to other EU countries. Moreover, the country has one of the highest rates of early leavers from education in EU (17% in 2013), with these rates gradually increasing. As a result, fewer students enroll in higher education, Romania having one of the lowest rates of university graduates in the EU (24.4%). While these statistics are alarming and depict the poor state of education in Romania, they also speak about *the need to improve* students' academic experiences, especially in the STEM fields which are vital in an increasingly worldwide competitive culture.

4. Methodology

4.1. Participants. Participants ($n = 210$) in the current study were children from Romania aged between 9 and 12 years old (average age was 10 years old). Demographic data showed that 108 (47.6%) students were female and 100 (51.4%) students were male. Among them, 143 (68.1%) participants were from 4th grade, 42 (20%) were from 3rd grade, and 25 (11.9%) were from 5th grade.

With respect to their ethnic membership, the majority of students were Romanians ($n = 156$; 74.3%), followed by students from other ethnic groups, such as Roma ($n = 15$; 7.1%), Hungarian ($n = 7$; 3.3%), and Ukrainian ($n = 11$; 5.2%). With respect to religion, students indicated in their survey that a total of 158 (75.2%) identify themselves as Romanian-Orthodox, 11 (5.2%) as Greek-Catholics, 7 (3.3%) as Romano-Catholics, and 34 (16.2%) students indicated their religion as "Others". Participants' demographic data are displayed in Table 1.

4.2. Data Sources and Procedures. The primary data for the current study were students' depictions of scientists using the DAST (Draw-a-Scientist-Test). Additionally, a survey (postdrawing) collected demographic data such as students' age, gender, ethnic membership, and rural or urban setting and if they visited science labs or science museums before. Appendix A presents the DAST activity and the survey.

Two researchers involved in the current study collected data spanning across one academic year (during 2015-2016). Both researchers are native Romanians, thus speak the language. All students received materials in Romanian and instructions to complete the study in Romanian. Study materials were collected in Romanian and later translated into English.

The DAST activity lasted for about 30 min, followed by a 10-min survey; students completed these activities in their own classrooms. One researcher collected data from a set of classrooms, while the other researcher collected data from another set of classrooms. All students in the study received the same instructions for completing the activity, and a standardized procedure was put in place for data collection. The students completed first the DAST activity and then completed the demographic survey (paper-and-pencil).

On their drawings, students were instructed to (1) provide a title for their drawing, (2) draw a person who works in science, and (3) provide a short description (in one or two sentences) of what the person is doing in their representations. Because Romanian is a Romantic language, similar to Spanish and French, the word "scientist" has already a gender connotation (i.e., "un om de stiinta" means literally "a male scientist"). In order to avoid gender bias, and thus avoid influencing students' depictions, we worded the instructions on the activity as gender neutral, asking children to draw "a person who works in science".

4.3. Data Sources and Analysis. Students' depictions of scientists were the primary data in our study. Quantitative data analyzed in the current study consisted in students'

Table 1: Participants' characteristics ($n = 210$).

Characteristics	n	%
Age		
9–10	159	77.56
11–12	46	12.6
Total	205	97.6
Missing	5	2.4
Grade		
3rd grade	42	20.0
4th grade	143	68.1
5th grade	25	11.9
Gender		
Female	108	51.4
Male	100	47.6
Total	208	99.0
Missing	2	1.0
Religion		
Orthodox	158	75.2
Greek-Catholic	7	3.3
Romano-Catholic	34	16.2
Others	52	24.7
Location		
Urban	166	79
Rural	44	21
Visits to a science laboratory	39	18.7
Visits to a science museum	126	60.6

scores on their drawings and survey data (i.e., demographic information, visits to science labs, and science museum).

The first step in data analysis consisted in data coding. A numerical code was assigned to each drawing. The coding rubric (Appendix B) was adapted from Mason et al. [39] and included coding categories for stereotype indicators on six areas, as follows: personal characteristics (i.e., lab coats and eyeglasses), symbols of research (i.e., test tubes and experimental animals), symbols of knowledge (i.e., equations on board), signs of technology (i.e., machines and solutions in glassware), and specialty of the scientist (i.e., chemist, biologist, and physicist). Each category also had an "Others" section where we coded any significant items identified in the students' drawings (e.g., representations of rockets, computers, and syringes). Each drawing thus received a stereotype indicator score based on the total number of stereotypical items identified in the drawing. The total stereotype indicator score can range from 0 to 17. A score of 0 indicates a drawing without specific stereotypes in depicting the scientists (e.g., having both a male and female scientist working in an outdoor science project with a neutral physical appearance). A score of 17 indicates a drawing with the highest stereotype indicator score (e.g., a male scientist working in a chemistry laboratory with a specific physical appearance, such as unkempt, sinister, or eccentric).

Additionally, each drawing was labeled as "positive," "neutral," "sinister," or "eccentric" (see coding rubric in Appendix B). The scientists' depictions were labeled as "positive" when they were portrayed in a nontraditional setting, using uncommon or outdoor lab equipment, such as working in an outdoor environment or in a setting other than a typical laboratory. Scientists were labeled "eccentric" when students portrayed them with unkempt appearances, bloodshot eyes, and antisocial (nerdy) characters, and "sinister" if images had violent explosions, evil facial expressions, or displayed violent behavior. Also, part of the coding, we included characteristics related to whether the students' drawings appeared to be some kind of nonhuman rendering, such as a "fantasy" figure or a "monster". Additionally, coding included the presence or absence of occupational details (e.g., animals, syringes, lab coats, head lamps, chalkboards, and books).

The coding procedure followed the guidelines of qualitative research [42] and consisted in two phases, as follows:

> *Phase 1: Testing and Reliability.* Two coders read all drawings and tested the existing coding scheme to establish reliability. To test the coding scheme, both coders selected randomly 15 drawings, a portion of the existing data. These 15 drawings were then coded independently by each coder. Once the independent coding was done, the two coders met to compare their codes, discuss their coding procedures, and adjust the coding scheme as needed.
>
> *Phase 2: Data Coding.* In the second phase of the coding, all drawings were coded by one coder only, after both coders made sure they tested the coding scheme and they reached 100% agreement on coding procedures [42]. One researcher coded thus the rest of the drawings using the same coding scheme which was tested and proved reliable.

Furthermore, to answer each research question, comparative analyses (i.e., one-way analysis of variance, ANOVA, and t-tests), chi-square tests, and regression analysis were conducted. Results from these analyses are presented below.

5. Findings

RQ#1: what do students' drawings reveal with respect to scientists' (a) appearance, (b) specialty, and (c) gender.

In the current study, the obtained average stereotype indicator score for students' drawings was 3 (SD = 2.3, min = 0, and max = 9). The overall stereotype indicator score can range from 0 to 17. Scores for scientists' representations on various areas, including appearance, specialty, and gender, are summarized in Table 2.

5.1. Scientist's Appearance, Specialty, and Gender

5.1.1. Scientist's Appearance. Data were analyzed based on frequencies of stereotypic indicators represented in students' drawings. The majority of drawings, 164 (78.1%), portrayed the scientists with a *neutral overall appearance*; neither positive, sinister, nor eccentric attributes was present. However, the rest of the drawings, 51 (28.1%), represented scientists with an unkempt appearance (i.e., wild hair, blood shot eyes, antisocial, and unusual expression).

Additionally, in terms of depicting scientists' *personal characteristics*, 66 (31.4%) of the drawings presented scientists wearing a lab coat, and 57 (27.1%) of the drawings

Table 2: Students' overall representation of scientists (n = 210).

	All students n = 210 (%)	Female n = 108 (%)	Male n = 100 (%)
Personal characteristics			
Lab coats[a]	66 (31.4)	37 (34)	29 (29)
Eyeglasses	57 (7.1)	30 (27.7)	27 (27)
Facial hair	08 (4.3)	4 (3.7)	4 (4)
Unkempt appearance	58 (28.1)	27 (25)	31 (31)
Symbols of research			
Test tubes[a]	107 (51.0)	58 (53)	49 (49)
Flasks[a]	103 (49.0)	59 (54)	44 (44)
Microscopes	22 (10.5)	7 (6)	15 (15)
Bunsen burner[a]	35 (16.7)	21 (19.4)	14 (14)
Experimental animals	18 (8.6)	13 (12)	5 (5)
Symbols of knowledge			
Books	08 (3.8)	5 (4.6)	3 (3)
Filing cabinets	12 (5.7)	7 (6.4)	5 (5)
Symbols of technology			
Solutions in glassware[a]	113 (53.8)	60 (55.5)	53 (53)
Machines	15 (7.6)	7 (6.4)	8 (8)
Gender of scientists			
Female	49 (23.3)	48 (44)	1 (1)
Male	142 (68)	53 (49)	89 (91.7)

[a]Considered as an indicator of a chemistry laboratory.

depicted scientists wearing eyeglasses. See Figure 1 for an illustration (Drawing ref. RO204).

5.1.2. Scientist's Specialty

(i) Chemists and Doctors. Relative to the entire sample size, a large number of students, 129 (61.4%) used at least one indicator of a chemistry laboratory. Specifically, 107 (51%) drawings included test tube(s) and 103 (49%) had flasks. Solutions in glassware were present in 113 (53.8%) of the drawings. Additionally, 35 (16.7%) of the drawings had Bunsen burners in their depictions of scientists. Students not only had drawn elements of a chemistry-related lab, but also many of them, 14 (6.7%), even wrote the words "chemist," "chemistry," and "chemical scientist" in their drawings. In the coding rubric, five categories were identified as stereotype indicators of a laboratory in chemistry or related area (i.e., biochemistry and chemical engineering). These five categories were lab coats, test tubes, flasks, Bunsen burner, and solution in glasses. Figures 2 and 3 illustrate students' representations of chemists.

However, a few other specialties (n = 15; 7.1%) were also represented in students' drawings. Among them, microbiologists and physicists are notable, but also archaeologists and astronauts were included. Interestingly, doctors have been represented as scientists on 23 (11%) of the drawings. Among them, 7 (3.3%) drawings included medical masks, 7 (3.3%) included syringes, and 3 (1.4%) included stethoscopes. A small number of students (n = 4; 1.9%) used the term "medical scientist" in their title, and others (n = 19; 9%) used the term "doctor" either in their title or in the short description provided alongside their drawings (to describe what the person working in science is actually doing). Figure 4 illustrates a representation of scientists as doctors.

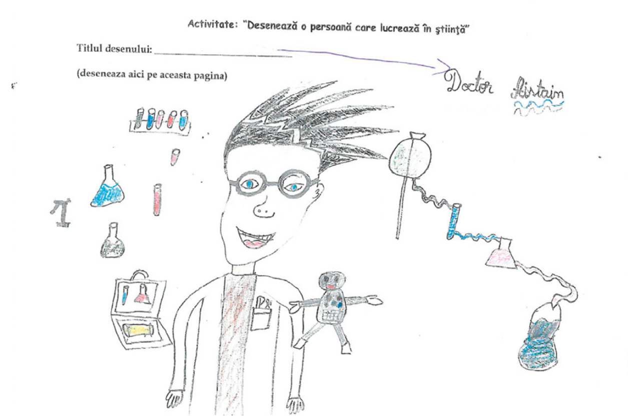

Figure 1: [Drawing ref. RO204]-Illustration of a scientist's personal characteristics.

5.1.3. Scientist's Gender. A prominence of male scientists was observed among students' drawings (Table 2). The scientist's gender was recognized by the body shape, facial structure, length of hair, and presence or absence of makeup. The majority of drawings, 142 (67.6%), represented drawings of male scientists. Only about a quarter, 50 (23.8%), of the drawings represented a female scientist.

RQ#2: in what ways do student characteristics, such as ethnic membership, religion, school location (i.e., rural versus urban), gender, grade level, and age, influence their perceptions and stereotyping of scientists?

To explore how students' demographics can predict stereotyping, we conducted a multiple hierarchical regression using factors in the following three stages: (a) Stage 1, primary characteristics (age and gender); (b) Stage 2,

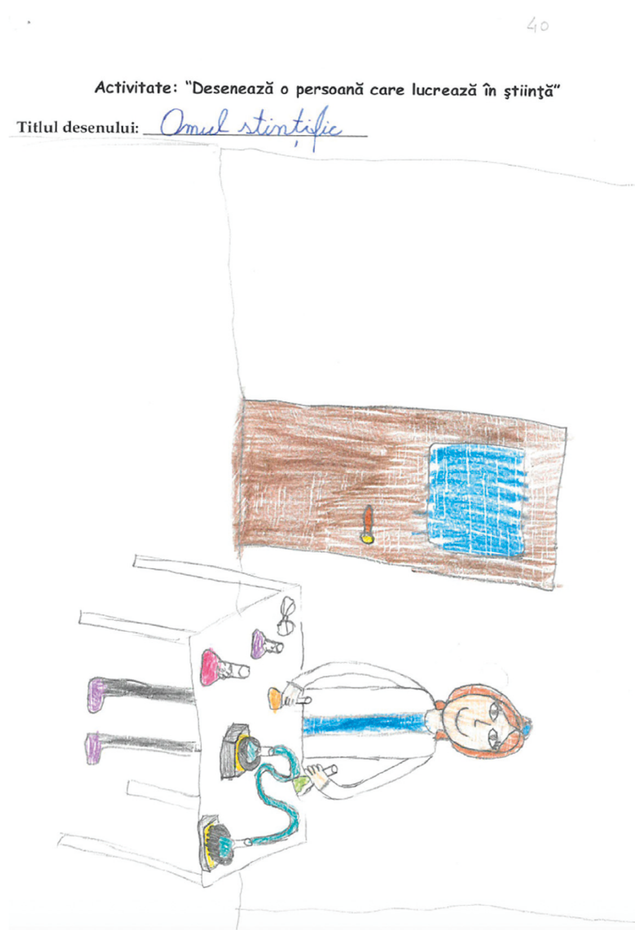

FIGURE 2: [Drawing ref. RO40]-Illustration of a scientist's specialty as chemistry.

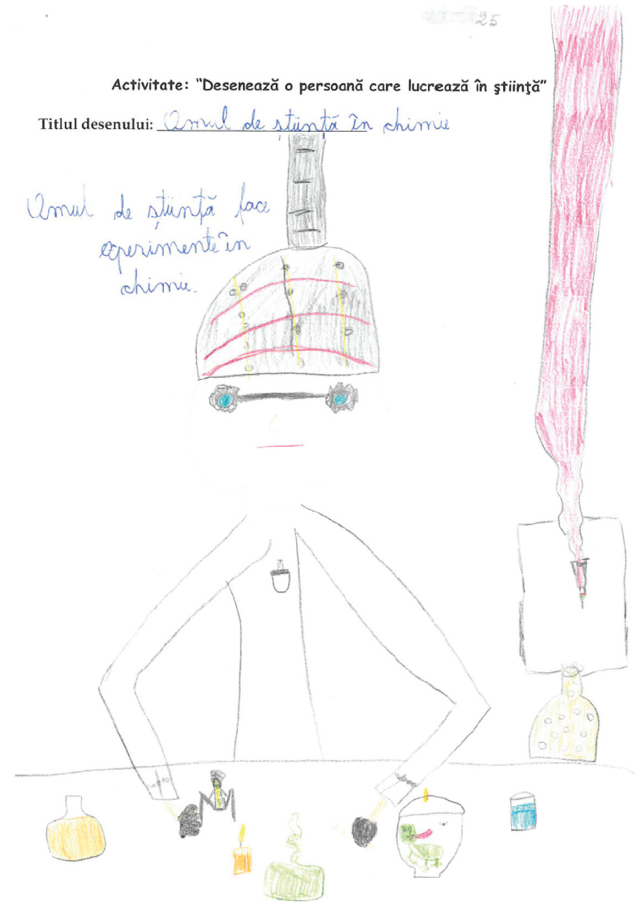

FIGURE 3: [Drawing ref. RO25]-Illustration of a scientist's specialty as chemistry.

secondary characteristics (school location, grade, religion, and ethnicity); and (c) Stage 3, probable characteristics (visit to a science laboratory and visit to a science museum). At Stage 1, age and gender accounted for a significant 6% of the variance in the stereotype indicator scores, $F(2, 200) = 7.446$, $p < 0.001$. Introducing grade, location (urban or rural), religion, and ethnicity explained an additional 9.7% of the variance, $F(6, 196) = 4.601$, $p < 0.001$. Finally, the addition of "visit to a science lab" and "visit to a science museum" to the regression model explained an additional 12.7% of the variance in stereotype indicator score, $F\ (8, 194) = 4.585$, $p < 0.001$. Together, all independent variables accounted for 12.4% of the variance in stereotyping, *Adj.* $R^2 = 0.124$, $F\ (7, 194) = 4.585$, $p < 0.001$. Table 3 summarizes the results.

5.2. Student Characteristics in Relationship with Stereotyping Scientists

5.2.1. Ethnicity, Religion, and School Location. Our findings revealed no significant differences with respect to students' ethnic membership ($\beta = 0.100$, $t = 1.22$, $p = 0.430$), students' religion ($\beta = -0.072$, $t = -.996$, $p = 0.755$), or school location, such as urban or rural ($\beta = 0.463$, $t = -0.618$, $p = 0.320$), and the score for indicators of stereotyping scientists.

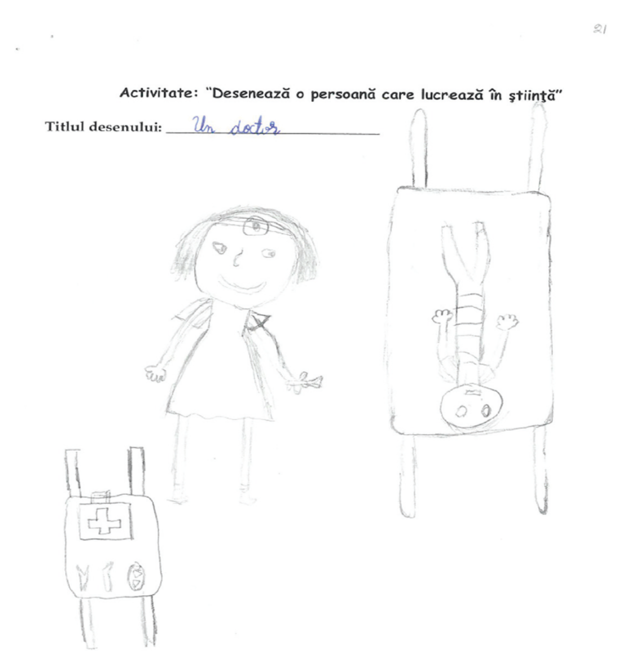

FIGURE 4: [Drawing ref. RO21]-Illustration of a scientist's specialty as medical doctor.

Table 3: Multiple hierarchical regression analysis predicting students' stereotyping of scientists.

Model	Independent variables	Standardized coefficient (β)	t	F	Adj. R^2
1	Age	−0.257	-3.761^{***}	7.446^{***}	0.060
	Gender	−0.043	−0.625		
2	Age	−0.007	−0.070	4.601^{***}	0.097
	Gender	−0.059	−0.861		
	Grade	−0.347	-3.347^{**}		
	Religion	−0.078	−1.058		
	Ethnicity	0.075	0.905		
	Location (urban/rural)	−0.039	−0.487		
3	Age	0.004	0.037	4.585^{***}	0.124
	Gender	−0.061	−0.908		
	Grade	−0.338	-3.294^{***}		
	Religion	−0.072	−0.996		
	Ethnicity	0.100	1.223		
	Location (urban/rural)	−0.049	−0.618		
	Visit to a science lab	0.038	0.560		
	Visit to the science museum	−0.196	-2.816^{**}		

$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p \leq 0.001$.

Additionally, one-way analysis of variance (ANOVA) results showed no significant differences in stereotyping between students from different religions, F (3, 206) = 0.399, p = 0.755. No significant differences were found with respect to students' ethnicity, F (3, 206) = 2.63, p = 0.051, or school location (rural versus urban), F (1, 208) = 0.995, p = 0.320.

5.2.2. Student Gender and Indicators of Stereotyping Scientists. The majority of students' drawings, 142 (67.6%), presented drawings of male scientists, and only 50 (23.8%) drawings represented a female scientist. Among the 108 female students, 48 (44%) drew female scientists and 53 (49%) drew male scientists. In contrast, among the 100 male students, 91 (91%) drew a male scientist and only 1 (1%) drew a female scientist. In the other 8 (8%) drawings, the scientists' gender could not be identified. Figure 5 illustrates a female scientist.

A chi-square test of interdependence was calculated to compare the frequency of scientists' gender between boys and girls. A significant interaction was found ($\chi^2(3) = 54.33$, $p < 0.001$), which suggests that there are significant differences in frequencies ($p < 0.001$) between boys' and girls' depictions of scientists with respect to scientists' gender. However, further results from an independent t-test found no statistically significant differences between female ($M = 3.1$, SD = 2.4) and male students ($M = 2.8$, SD = 2.1), t (206) = 0.809, p = 0.419 with respect to their *obtained score on stereotypic indicators*.

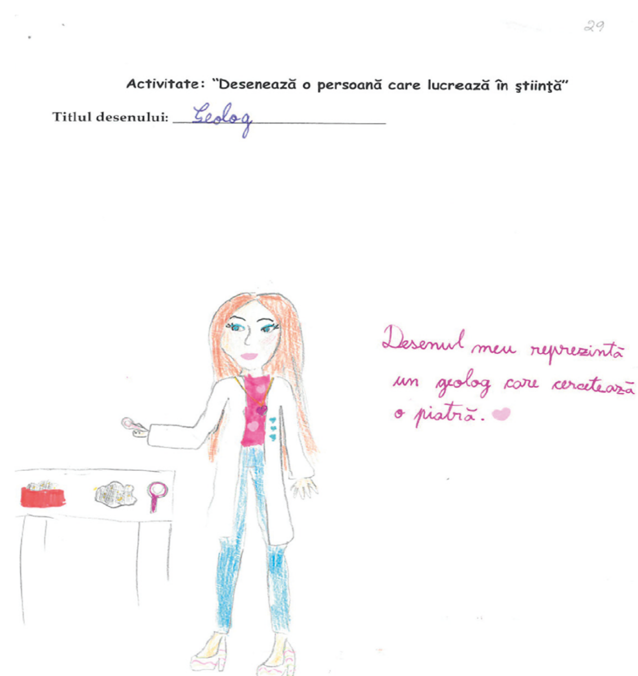

Figure 5: [Drawing ref. RO29]-Illustration of a scientist's female gender characteristics.

5.2.3. Student Grade Level and Age

(i) Grade. Students' grade level statistically significantly and negatively correlated with students' stereotype indicator scores ($r = -0.341$, $p < 0.001$). In the multiple hierarchical regression model, controlling for other demographics and "visit to a science lab" and "visit to a science museum", grade level can statistically significantly predict the stereotype indicator score ($\beta = -0.338$, $t = -3.29$, p = 0.001). To further analyze how the grade level was associated with the stereotype indicators, ANOVA was used. The grouping variable in the ANOVA were the three grade levels, namely, 3rd, 4th and 5th grades (see groups' representation in Table 4).

As group sizes largely differed and the Levene's test revealed, the homogeneity of variance was not met ($p < 0.001$). Thus, the *Welch's F* test was used. The *Welch's* ANOVA between students' grade level and stereotype indicator was statistically significant, *Welch' F* (2, 75.6) = 36,

Table 4: Means and standard deviations of social stereotype indicator scores by grade level.

Grade level	Age (years)	n	M	SD
Grade 3 (n = 42)	8-9	35	4.04	2.24
	10-11	7		
	12-13	0		
Grade 4 (n = 143)	8-9	13	3.01	2.28
	10-11	126		
	12-13	0		
	Not indicated	4		
Grade 5 (n = 25)	8-9	0	1.08	1.03
	10-11	17		
	12-13	7		
	Not indicated	1		

Table 5: Post hoc results for stereotype indicator scores by grade level.

Grade	Level	Mean (SD)	Mean differences ($\bar{X}_I$-$\bar{X}_j$)		
			1	2	3
(1)	Grade 3	4.04 (2.42)	—		
(2)	Grade 4	3.01 (2.28)	1.03*	—	
(3)	Grade 5	1.08 (1.03)	−2.96***	−1.93***	—

$^{*}p < 0.05$; $^{***}p < 0.001$.

$p < 0.001$. Additionally, as there was a slight skewness in two of the groups, a nonparametric *Kruskal–Wallis H* test was also used, and the results confirmed that there was statistically significant difference in stereotype indicator scores between the grade levels, $H\,(2) = 26.9$, $p < 0.001$, with a mean rank of 133.2 for grade 3, 106.3 for grade 4, and 54.5 for grade 5. Games-Howell post hoc revealed that grade 3 ($M = 4.04$, SD = 2.24) had a significantly higher average score than grade 4 ($M = 3.01$, SD = 2.28) and grade 5 ($M = 1.08$, SD = 1.03). See Table 5 for a summary of results.

(ii) Age. Students' age level statistically significantly and negatively correlated with students' stereotype indicator scores ($r = -0.258$, $p < 0.001$). However, in the multiple hierarchical regression, controlling for the other demographics and "visit to a science lab" and "visit to a science museum", the model showed that students' age cannot statistically significantly predict the stereotype indicator score ($\beta = 0.004$, $t = 0.037$, $p = 0.971$). Although, in the first stage (block 1), age can significantly predict stereotyping ($\beta = -0.257$, $t = -3.76$, $p < 0.001$); on the second and third stage (block 2 and 3), when grade, location, religion, ethnicity, and visits to science labs and museums were introduced, age did not significantly predict stereotyping.

RQ#3: in what ways does access to scientific and educational places, such as (a) science laboratories and (b) science museums, influence children's perceptions and stereotyping of scientists?

5.3. Visits to Science Laboratory and Stereotyping. Only 39 (18.6%) students indicated in their survey responses that they visited a science laboratory. The regression model shows that visiting a science laboratory did not significantly predict students' stereotyping ($\beta = 0.038$, $t = 0.560$, $p = 0.576$). Independent t-test results showed no significant differences in the stereotype indicator scores between students who visited a science laboratory and students who did not, $t\,(207) = 0.216$, $p = 0.829$.

5.4. Visits to Museums and Stereotyping. The multiple hierarchical regression model suggests that controlling for students' age, gender, grade, and location, students' visit to science museums can statistically significantly predict students' stereotype indicator scores ($\beta = -0.187$, $t = -2.8$, $p < 0.01$). For further analysis, independent sample t-tests were performed comparing the score of stereotypic indicators and students' visit to museums. Table 6 presents the results.

Results show that students who indicated in their survey responses that they *visited science museums* (n = 126; $M = 3.4$, SD = 2.4) *scored significantly higher in stereotyping indicators* than students who indicated in their survey that they have not visited science museums (n = 82; $M = 2.4$, SD = 2.0, $t\,(206) = 3$, $p < 0.05$). With respect to scientists' specialty, students' who visited science museums ($M = 2.3$, SD = 1.7) represented more often a chemistry laboratory than students who have not visited a science museum, $t\,(206) = 3$, $p < 0.05$.

6. Discussion

The current study investigated students from Romania and their representations of scientists using the Draw-a-Scientist-Test (DAST). Overall, study findings showed that most students *represented male scientists* in their drawings; the common image of a scientist was that of a white male wearing a lab coat with a facial appearance resembling images of popular scientists (i.e., Einstein). In terms of specialty, most students represented *scientists as chemists*; a few drawings represented scientists as medical doctors.

Furthermore, our results indicated a statistically significant difference in students' score of stereotyping indicators with respect to student *grade level.* In the current study, students from grades 3, 4, and 5 were included. Students in lower grade levels tended to have higher stereotyping indicator scores. Moreover, an interesting finding revealed that students who indicated in their survey responses that they *visited science museums scored significantly higher in stereotyping indicators* than students who indicated in their survey answers that they have not visited science museums. However, there were no significant differences between students who indicated in their survey responses that they *visited a science laboratory* compared to students who indicated in their survey answers that they have. The main key points from our findings, along with a brief discussion, are summarized below.

6.1. Types of Stereotyping

6.1.1. Scientist's Gender. The majority of drawings represented male scientists, and only about a quarter represented

Table 6: Students' visit to science museums and scores on stereotype indicators.

	Visits to museums		
	Yes ($n = 126$) Mean (SD)	No ($n = 82$) Mean (SD)	t
Indicators of a chemistry laboratory (*5 components in total)*	2.3 (1.7)	1.6 (1.6)	3^{***}
Total indicators of stereotyping	3.4 (2.4)	2.4 (2.0)	3^{***}
Personal appearances *(5 components)*	1 (1.0)	0.7 (0.9)	1.9^{*}
Symbol of research *(5 components)*	1.5 (1.2)	1.1 (1.1)	2.4^{*}
Symbols of knowledge *(2 components)*	0.1 (0.4)	0.04 (0.2)	1.6
Symbol of technology *(2 components)*	0.7 (0.6)	0.5 (0.6)	2.4^{*}

Note: for specific component under an indicator, please see Table 2. $^{*}p \leq 0.05$; $^{***}p < 0.001$.

a female scientist. Male students drew predominantly male scientists; only one male student drew a female scientist. Among the female students, about half of them drew female scientists, and the other half drew male scientists. Reflecting on previous studies [8, 9, 22, 23], an overall dominance of male scientists is present in both female and male students' drawings. Although students tend to draw images of the same sex people [32, 43, 44], this factor seem to be less influential in our study. However, as Miller et al. [9] pointed out, young children possibly draw images of their own sex because they have limited knowledge of scientists. Studies conducted with K-12 students and teachers in which they were asked to depict engineers [45–47] showed similar results in terms on gender stereotypes. Cruz López et al. [46] point out that even though the female participants in their study were almost 60% of the participants, the majority (63%) of the drawings depicted a male engineer at work, while 24% of K-12 students included a male and a female or a neutral figure in their drawing.

6.1.2. Scientist's Specialty. Findings revealed that chemistry reins in stereotyping scientists among our study population, which is in line with previous findings [18, 23]. Relative to the entire sample size, a large number of students used at least one indicator of a chemistry laboratory. Interestingly, in the current study, doctors have been represented as scientists in about a quarter of drawings. However, all representations of scientists as doctors were found in students' drawings from rural schools. This could indicate that their most close encounter with a science-like lab was that of a doctor's office.

6.1.3. Differences in Students' Grade Level and Age. In our study, we found statistically significant differences between student grade level and indicators of stereotyping scientists. A hierarchical multiple regression model revealed that students' grade level statistically significantly predicted their stereotyping score. Students in grade 5 showed significantly lower stereotyping than students in 3rd and 4th grade level. These results seem to indicate that students in higher grade levels stereotype less compared to their peers in lower grade levels. This finding remarkably contradicts with the previous study findings which suggest that as age and grade level increase, students' stereotyping are elevated too [9, 15]. A probable explanation for our finding can be that students' exposure to a more complex science curriculum, as they progressed through their grade levels, reduced stereotyping. However, limitations in group homogeneity may affect the results in this case. In our sample, students from grade 5 represented the smallest group, compared to grade 4 and grade 3. We discuss this aspect in study limitations.

6.1.4. Visits to Museums and Science Laboratories. An interesting and novel finding from our study was related to students' visits to science museums. Students who indicated in their survey responses that they *visited science museums scored significantly higher in stereotyping indicators* than students who indicated on their survey answers that they have not visited science museums. This is a noteworthy finding, but further research on this area should be conducted to support such findings. It is possible that museums they visited focused on presenting scientists from the past centuries, and thus the scientists were predominantly white males which contributed to supporting students' perceptions about who scientists are. Science museums should make efforts to include contemporary scientists in their exhibitions and focus on representing a diversity of scientists (e.g., gender and ethnic representation, as well as various types of specialties in science).

However, findings related to students visiting a science laboratory did not show significant results. Students who visited a science laboratory did not show significant differences in their perception of scientists compared to students who did not visit a science laboratory. One possible explanation is that since a very low number of students from or sample visited a science lab, it is most likely that their sources of scientists' images came from other contexts (e.g., media, TV, books, and cartoons) than visiting a science lab.

7. Implications

Findings from prior studies using "Draw-a-Scientist Test" (DAST) suggest that students see scientists predominantly as white, often unattractive men; one consequence may be that girls and minority students do not identify with science careers and feel that a science career is "not like me" [8, 48, 49]. Our research findings revealed that Romanian students from our sample had stereotypical images of scientists, in line with previous studies conducted in this area. Implications from our study could help educators and policy makers in Romania develop science initiatives, similar to those implemented in other countries (i.e., the US and UK) that support a strong STEM education, and implement a science curriculum that values diversity and research-based practices.

Studies show that both informal and formal science experiences can be a strong influence on students' perceptions of science and scientists [30]. Studies that related students' out-of-school experiences with their perceptions of scientists revealed that such experiences can help students develop more adequate perceptions about scientists and the nature of their work [30, 50]. Research findings suggest that students' scientific views and understanding of science evolve when they are given out-of-school opportunities to explore science *paired up with a rigorous formal science instruction* [50]. As such, visits to science museums, zoos, and botanical gardens and participating in dialogues between peers can help students develop an understanding of science and provide opportunities to discuss stereotypes about scientists [51, 52]. Hence, involving students in authentic science activities will provide them with valuable learning experiences, helping them to enhance their science content and views about the science careers. For instance, science summer camps, mentorship experiences with scientists, science magnet schools, and STEM-focused programs in public schools are a few examples of programs implemented throughout the US. Similar programs can be adopted to Romania where the educational system provides very little support for students' STEM preparation at the elementary level and STEM-focused programs are needed.

Furthermore, teachers' role is significantly important in providing formal and informal science experiences to students addressing the role of science and scientists. Providing students with various instructional modes (i.e., active and inquiry-based) and immersive experiences (e.g., lab research experiences with a scientist) would facilitate students' conceptual understanding about the nature of science and scientists' work.

Additional research regarding attributes of *role models* in a given field can highly influence the perspective of observers about that field [53]. In several studies, students' representations of scientists reflected or specifically mentioned well-known scientists such as Albert Einstein and Newton [21, 54]. A recent study explored how the presentation of a role model can impact students' beliefs about success in science [55]. In this study, a group of 9th and 10th grade students read one out of three types of stories about renowned scientists describing (a) the scientist's intellectual struggles, (b) struggles in scientist's personal life, and (c) success in science career. Results revealed that students who read the struggle stories improved science learning, compared to those who read the success story [55]. Hence, adopting curriculum that would include biographies of scientists to represent diversity among scientists and a diversity of experiences in science, including scientists' struggles, can provide valuable learning tools for students about who scientists are and what is the nature of their work.

7.1. Limitations and Future Studies. One limitation of the current study could be related to students' demographic data and samples. Participants were all upper elementary school students (grades 3–5), and all of them identified themselves as White-Caucasians (Table 1). Additionally, students' grade level differences did not meet the homogeneity of variance assumption as sample size in each group largely varied. There were few students from 5th grade ($n = 25$; 11.9%), compared to 4th grade ($n = 143$; 68.1%) and 3rd grade ($n = 42$; 20%). This may have influenced our comparative results regarding student grade levels with respect to perceptions of scientists.

Future studies could address these limitations and also focus on including systematic extensions to other jobs to assess where scientists "fit" as occupational incumbents. It could also be helpful to consider other student characteristics and relationship with the type/quality of drawings produced. For example, do high academic achievers depict scientists differently from less achieving students? Or, do students with low socioeconomic-status (SES) depict professions, especially scientists differently than high SES students? Additional future studies could explore, in addition to demographic and cultural factors, the role of psychological factors, such as the impact of motivational beliefs (i.e., efficacy) or the effect of mindsets on students' depiction of scientists and domain identification.

Appendix

A. Draw-a-Scientist Test (DAST) and Survey

(I) Activity: "Draw a scientist".

Directions: draw a person who works in science

Title of your drawing: ________________________________

(II) Survey

On this page, please tell us:

(1) Drawing # ______________(researcher only)

(2) Your age:

(3) Are you a girl or a boy? (circle an answer):

(i) Girl

(ii) Boy

(4) What language are you speaking at home with your family? (circle an answer):

(i) Romanian

(ii) Hungarian

(iii) German

(iv) Others (please fill in):____________________

(5) What religion is your family (circle an answer)?

(i) Orthodox

(ii) Greek-Catholic

(iii) Romano-Catholic

(iv) Protestant

(v) Muslim

(vi) Others (completeaza):

(6) Have you ever visited a science laboratory outside of your school? (circle an answer):

(i) Yes

(ii) No

(7) Have you ever visited a science museum? (circle an answer):

(i) Yes

(ii) No

B. Coding Rubric for the Draw-a-Scientist Test (DAST)

How many drawings included the following	Tally	Score
Personal characteristics		
Laboratory coats		
Eyeglasses		
Facial hair		
Pencils/pens in pocket		
Unkempt appearance		
Symbols of research		
Test tubes		
Flasks		
Microscope		
Bunsen burner		
Experimental animals		
Others		
Please list “other” symbols of research		
Symbols of knowledge		
Books		
Filing cabinets		
Others		
Signs of technology		
Solutions in glassware		
Machines		
Others		
Please list “other” symbols of technology		
Scientist’s specialty		
No specialty		
Yes		
Cannot tell if it is a scientist		
How many drawings depicted women and men		
Drawing of men		
Drawing of women		
Drawing in which you cannot tell if scientist is a man or woman		
Scientist’s racial or ethnic group		
Scientists who appear to be Caucasian/White		
Scientists who appear to be African American, Hispanic or Native American		
Scientists who appear to be Asian or Asian American		
Drawings in which racial/ethnic group of scientists in not evident		
Total score		

Would you characterize the overall appearance of the scientist as

Eccentric–wild hair; clashing, unfashionable clothing; unkempt appearance; bloodshot eyes; bad complexion; antisocial (nerdy) characters

Sinister–violent explosions; evil facial expressions; animals crying or yelping for help; Frankenstein’s monster type characters; captions with violent language

Neutral–not necessarily positive or negative.

Positive–depicts the scientist in a nontraditional setting or using unusual or outdoor lab equipment.

Note: a drawing may have more than one of these characteristics.

Overall appearance	Tally marks	Score
Eccentric		
Sinister		
Neutral		
Positive		

Note: the coding rubric in the current study was developed based on the study of Mason et al. [39] and Barman [35].

Data Availability

The SPSS data file used to support the findings of this study has not been made available because of confidentiality reasons. For any questions, please contact Dr. Thomson.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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