Research Article https://doi.org/10.12973/ejmse.2.2.63

European Journal of Mathematics and Science Education

Volume 2, Issue 2, 63 - 83.

ISSN: 2694-2003
http://www.ejmse.com/

Differences and Similarities in Scientists' Images Among Popular USA Middle Grades Science Textbooks

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Received: June 6, 2021 ▪ Revised: September 26, 2021 ▪ Accepted: November 18, 2021

Abstract: Research on students' perceptions of scientists is ongoing, starting with early research by Mead and Metraux in the 1950s and continuing in the present. Continued research interest in this area is likely due to scholarship suggesting adolescents' impressions of scientists are sourced in-part from media, which influence their interests in science and identity in becoming a scientist. A significant source of images, in which adolescents (or middle school students) view science and scientists, is in their science textbooks. A qualitative content analysis explored images of scientists in three of the major U.S.-based middle grade science textbooks published in the new millennium: sixth grade biology, seventh grade earth science, and eighth grade physical science. The Draw A Scientist Test (DAST) Checklist was employed to assess scientists' images and the stereotypes therein. From nine textbooks, 435 images of scientists were coded and analyzed by publisher and grade level / area by DAST constructs of appearance, location, careers, and scientific activities. Statistical analyses showed significant variances between grade levels and textbook publishers of scientists. Despite scientists portrayed in active endeavors, traditional tropes of the scowling, older, solitary, white male scientist persist. This study offers insight in leveraging improved images of scientists in textbooks.

Keywords: *Draw-a-scientist-test, middle school, students' perceptions, scientists' images, textbooks.*

To cite this article: Hite, R. (2021). Differences and similarities in scientists' images among popular USA middle grades science textbooks. *European Journal of Mathematics and Science Education*, *2*(2), 63-83. https://doi.org/10.12973/ejmse.2.2.63

Introduction

Images are powerful since they have the power to insight emotions, construct information, confirm or refute stereotypes (Weber & Mitchell, 1995). For children and adolescent learners, images play in influential role in their perceptions of scientists, which have evidenced by the plethora of research exploring scientists in film (Steinke, 2005), the media (Steinke et al., 2006, 2007, 2009), television (Steinke et al., 2008), trade books (Finson et al., 2017; Ford, 2006), and on the internet (Fujiwara et al., 2021). Thus, the exploration of students' perceptions of science and scientists is not a new endeavor, starting with early research by Mead and Metraux (1957), continuing to present day (e.g., Ferguson & Lezotte, 2020) and expanding internationally (e.g., Chionas & Emvalotis, 2021). A common and coherent strategy to both elicit and understand students' perceptions of a scientist is the *Draw a Scientist Test* (DAST; Chambers, 1983) and checklist (DAST-C) (Finson et al., 1995), respectively. When administering the DAST, students are prompted to draw their idea of a scientist, particularly one at work. These sketches are collected and analyzed using the DAST-C. Based upon attributes of the scientist drawn, such as their apparent gender, race/ethnicity, clothing, environment and activities, one can qualify perceptions and stereotypes therein (Barman et al., 1997). According to a meta-analysis of DAST research by Finson (2002), K-12 students held common perceptions of scientists as white males who generally engaged in dangerous, secretive, or even wacky behaviors. Early research suggests that these stereotypical perceptions progress over time, sometimes even being formed in the primary grades (Chambers, 1983; Schibeci & Sorensen, 1983). Yet through many decades of using this inventory, "researchers who have studied children's perceptions of scientists found pervasive, but questionable, preconceived ideas of scientists among *all age levels of children*" (Buldu, 2006, p.122). This suggests there is a common or at least consistent factor that could be influencing students over time.

A significant and persistent source of images in which students view scientists is in their science textbooks, a ubiquitous fixture of teaching and learning in U.S. K-12 education (Kulm et al., 1999), and especially in science education (Kuechle, 1995). Because teachers heavily utilize textbooks for 75% to 90% of science curriculum and instruction (see DiGiuseppe,

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2014). Further, "textbooks are an important resource for developing students' knowledge as they contain various *representations* [emphasis added] that influence students' learning" (Bergqvist & Chang Rundgren, 2017, p. 215). Since textbooks often spotlight and discuss life of scientists, may be why "since the early 1970s, concerted efforts have taken place to present inclusive images of scientists [in textbooks] to show how they engage in the scientific enterprise" (Barman et al., 1997, p. 689). Improvements to textbooks included the addition of special sections including highlighting scientists, careers, and interdisciplinary components like connecting science to history and society (Atwater et al., 1993). Newer efforts have been made at the upper primary (elementary) and lower secondary (middle) grades as research suggests science identity (seeing oneself as a scientist) is most malleable at that time (Kang et al., 2019; Vincent-Ruz & Schunn, 2018), decreasing as students age (Carlone et al., 2014; Skamp & Logan, 2005). It is during adolescence within middle school when students make assessments of their science interest (Maltese & Tai, 2010), science abilities (Britner & Pajares, 2001), and seriously consider science as a future career (Almeda & Baker, 2020; Bandura et al., 2001). Research affirms this time is particularly important among girls (American Association of University Women, 2000; Krapp & Prenzel, 2011; Lei et al., 2019; Maltese & Tai, 2010) and when students dismiss science as a viable career (Jones & Hite, 2021).

Adolescence is when girls' perceptions of science and scientists are sourced from and influenced by images of scientists. Per Steinke et al. (2007, p. 2-3), "images of STEM professionals in popular media have for many years both created and perpetuated a cultural stereotype that depicts women as less likely than men to be *present* [emphasis added] in STEM fields as well as less likely to be talented, successful, and valued in STEM fields…[notable] conveyed gender stereotyped images of STEM professionals [are] by mostly showing men as STEM *professionals* [emphasis added]." From this quote, Steinke introduces in her 2007 meta-analysis (on how adolescent girls' form their science identity) a few areas of nuance worth noting. First, she posits that in image-based media, women are simply left out. This asks the question to what degree women scientists are represented, at all, in images within science textbooks. This line of inquiry also suggests questions that are a bit more insidious. For example, among the images of women scientists that are shown in science textbooks, what types of jobs are these women scientists working? Are they jobs that require 4-year or professional (e.g., medical) degrees? Or are these science jobs low- or entry-level (2-year or certificate needed)? Even more, are these images of women scientists showing science jobs at all? Meaning, are they showing women engaging in science as merely a hobby, or in science adjacent jobs like making jewelry that suggest gendered undertones? To what extent are women working in professional science jobs as compared to male scientists shown in these science textbooks? These notions matter as Steinke elaborates in her review; she stated that such imagery shapes adolescents' perceptions of science occupations, calling for more research in how images elicit contextual clues that influence girls' science identity formation. For this reason, it was of research interest to determine how many times scientists were named or went unnamed in the present research. Providing the name of the scientist establishes a connection to that individual as a *person*. Thus, this asks, how many women are named? Are the numbers of named women different from named men? In addition to gender, Steinke suggests how scientists are portrayed affect girls, "images of STEM professionals not only have been unflattering and unfavorable but also often have been gender stereotyped…as male – as well as white, middle-aged or elderly, unattractive, dressed in a lab coat and glasses, geeky or nerdy, social awkward and individuals who work alone" (p. 2). Therefore, it is also warranted to explore the stereotypes being elicited by the images in addition to gender presentation, type of science work and whether or not the featured scientists are named. Therefore, use of the DAST-C is helpful to both identify and categorize the types of stereotypes, mentioned by Steinke, that may be contributing to adolescents' stereotyping of scientists. Therefore, analyzing images of scientists by DAST-related factors of the scientists' appearance, location doing science with or without other scientists, and the types of scientific activities they are engaged in, can provide greater information and visualization of stereotypes that students may develop from viewing their depictions in their science textbook.

Although many textbooks are now available online, due to inequity in internet access and shrinking district budgets, hardcover textbooks remain as a major source of preference among learners compared to their electronic counterparts (Millward, 2019; Woody et al., 2010). Further, research suggests undergraduate students learn more from print textbooks than screens (Alexander & Singer, 2017) possibly due to the increased amount of multi-tasking that students engage in when using electronic or online textbooks (Daniel & Woody, 2013), requiring them to use more self-regulation strategies to maintain their attention (Rockinson-Szapkiw et al., 2013). Pre-college students possess fewer metacognitive skills than their older counterparts, suggesting that print textbooks may have an educational advantage. Moreover, children from disadvantaged school districts also live in lower-income households; these children use older (and outdated) textbooks far more often than their higher-income peers (Hudley, 2013). Lower-income students not only use more print textbooks, but also use older textbooks. This is particularly problematic in the United States since lower income students attend less resourced schools and are disproportionately students of color (Brunner et al., 2021). Because print science textbooks may be one of the most consistent and omnipresent mean for student, especially for non-white and low-income student that are under-presented at each point in the U.S. science pipeline (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2011), these factors warrant an exploration to how scientists are depicted in the middle grades science textbooks to better understand how U.S. students, within the formative years of science interest and identity, view textbook's portrayals of scientists and how they could internalize those images (by using extant frameworks that explore student stereotyping of scientists like the DAST).

Many analyses of textbooks have been conducted over time regarding alignment to standards (Kesidou, & Roseman, 2002), coverage of science content (Skoog, 2005), and for international comparisons (Liang & Cobern, 2013). Yet, a qualitative analysis of middle grade science textbooks examining the portrayal of scientists (and how they are doing science) has been performed among states (e.g., Long et al., 2018), but not at a national scale. This study sought to garner a better understanding of how scientists are portrayed as individuals and engaged in scientific endeavors in middle grade science textbooks by the three major U.S. textbook publishers who supply the American middle grades science textbook market. Therefore, this study analyzed nine middle grade level science textbooks: in the three science subjects areas (i.e., biology, earth and physical science); from each of the three middle grade levels (i.e., sixth, seventh, and eighth grades); and from the three major U.S. textbook manufacturers (i.e., Holt/Houghton Mifflin Harcourt, Prentice Hall/Pearson, and Glencoe/McGraw-Hill) to explore and compare (statistically) the images that the textbook identified as scientists. Descriptive information was recorded for each image according to the DAST, DAST-C, and elements of the modified DAST (mDAST; Farland, 2003) frameworks to qualify scientists' depictions. The two research questions for this study are as follows:

(1) what is the distribution and demographics of scientists' images in middle grades science textbooks?
   a. What proportions are scientists named and unnamed in images? Are there differences by male and female gender?
   b. What types of STEM jobs are being shown in science textbooks? Are there differences by male and female gender?

(2) what evidence of DAST-based stereotypes in scientists' appearance and work are present in scientists' images?

Methodology

Research Design

To explore how scientists are represented in science in the middle grades, a descriptive research design was performed using deductive Qualitative Content Analysis or QCA (Schreier, 2012). Using QCA, images of scientists were sourced from the three top publishers of sixth grade biology, seventh grade earth science, and eighth grade physical science textbooks and coded according to a DAST-based framework to determine the distribution and demographics of scientists' images contained therein and the stereotypes they possibly convey.

Sample and Data Collection

Textbook selection was based upon the textbooks that were used most frequently in U.S. middle grade science classrooms. These textbooks were Holt (published by Houghton Mifflin Harcourt), Prentice Hall (published by Pearson), and Glencoe (published by McGraw-Hill) deployed in classrooms from 2005-2015. Data selection for images was for *named* (i.e., Albert Einstein, Jane Goodall) and *unnamed* (e.g. a geologist, chemist, etc.) scientists, in photographs, portraits, or paintings within the text of the student edition of the textbook. Notably, if an image contained more than one scientist, each scientist was coded and interpreted individually. The location in the text (including if the scientist was embedded into the content of the chapter or relegated to a *special section* of text) using the page number of each scientist was recorded (along with means and medians) as part of the audit trail.

Analyzing of Data

Among the nine sampled books, 435 images were identified as indicating someone who is a scientist. First, demographics of scientists were categorized. This included scientists' 1) apparent race, ethnicity and nationality, 2) gender presentation, and 3) the science occupation they were engaged in (i.e., a science career that warrants a 4-year or 2-year degree, or engaging science as a hobby (amateur) or not working in a science-adjacent job). Further, each category included whether or not the scientist was named or unnamed narratively (per the selection criteria) in the textbook. These descriptive statistics helped to qualify how scientists were being presented to students reading that textbook. Chi-square analyses and fisher exact tests (for smaller sample sizes) were employed for categorical comparisons using gender and a DAST construct. These analyses helped to provide understanding to how significantly uneven depictions may contribute to a diminished view of women in science and forge stereotypical views of scientists, respectively. For the latter, images were coded using the DAST-C. The elements of the coding schema originally developed by Chambers (1983), included more modern iterations (codes) from DAST developed by Finson et al. (1995), modified by Barman (1999), Steinke (2005), Steinke et al. (2007), Miele (2014), and the mDAST (Farland-Smith, 2012, 2017; Farland-Smith & Ledger, 2016). The combined DAST code book qualified stereotypical elements of scientists including: presenting as male; appearing Caucasian or white; wearing lab coats or eyeglasses; presence of facial hair; mythical attributes (mad scientist, crazy hair style); being middle-aged or elderly; working indoors (e.g. a laboratory) versus outdoors (e.g. out in the field); the specific site/location of work; the scientists' facial expression (smiling or not smiling); their use of research symbols including symbols of knowledge; types of technology they used; as well as any indications they were engaging in dangerous and secret behaviors. The codebook is available in Appendix A. From appendix A, coded elements included Personal Protective Equipment (PPE), age, facial expression and evidence of DAST-based stereotypical elements

(eyeglasses, facial hair, crazy hair, tie, pocket protectors, mythical/mad scientist features; featuring light bulbs, dangerous and secretive activity, potentially causing harm or distress). Third, general and specialized locations included their indoor or outdoor location, place where they did science (i.e., a lab, in the field, a hospital, classroom, office environment) and whether or not they were pictured working alone or in collaboration with other people. Last, images were examined in regard to how the scientist was portrayed in doing science: headshot only without a background; headshot with items within a foreground; a staged photo using items, and last, an image of a scientist engaging in real scientific activity. Other coded items from the DAST inventory included coding for *Symbols of Research* or working with living or non-living specimens, utilizing glassware or chemicals, manipulating a model, presenting data or research, and use of medical, space, or science tools and equipment. *Symbols of Knowledge* included computer software, filing cabinet/s, identification badge/credential, clipboard/s, book/s or textbook/s, pen in hand or pocket, and models, posters or chalkboards in use or in the scientists' background.

To ensure codes were applied correctly and consistently to each image by the coder after three rounds of coding, frequency counts were conducted by grade level (and associated science subject area) with constructs prescribed by DAST scholars. In total, 12 data tables were created with information on the images and analyses of statistical differences between gender presentation and DAST-related categories.

Trustworthiness

It is an imperative that qualitative research studies employ the highest standards of credibility, transferability, dependability and confirmability; these four dimensions help to establish the quality of the research study's process and its findings (Lincoln & Guba, 1985). For confidence in the study's findings (credibility), extant theory as validated in scholarship to the population of interest (adolescents' perceptions of scientists) was employed as both the theoretical and analytical framework using the DAST. The notion that this research is transferable lies within other scholars engaging in similar analyses of science textbooks to infer how they influence students' learning, perceptions, or other constructs of interest (e.g., Kesidou & Roseman, 2002; Liang & Cobern, 2013; Long et al., 2018; Skoog, 2005). In regard to the consistency of findings (dependability), triple coding was employed to ensure each image was coded consistently during the coding process. Images were part of an audit trail to see if they were double photos included (in which the same scientists were featured more than once in the textbook) which is recorded in the data tables. Areas in which assessments could not be made to a specific characteristic, there is an undermined category to quantify those instances. Further, the location in the text in which scientists' images were found was also included in the data tables. To ensure neutrality (confirmability), the coding process as well as codebook (Appendix A) are provided for transparency purposes.

Findings / Results

Data tables are parsed by the grade level and content area of sampled textbooks, from sixth grade biology to seventh grade earth science and eighth grade physical science. Textbook publishers (1 being Holt, 2 being Prentice Hall and 3 as Glencoe) are represented as columns and coded categories are found in each row. Figures are reported as Total (Male) (Female) and undetermined in italics. Tables 1, 2, and 3 show the coding and analyses for images of scientists being named, their demographic information, gender presentation, and science occupation; these three tables redress research question one. Tables 4, 5, and 6 show findings of scientists' appearances including their apparel, use of PPE, apparent age, and facial expression. In these tables, [a] indicates that many individuals were wearing clothes that could be coded underneath the lab coat, other images the lab coat was the only garment visible whereas [b] describes individuals wearing full helmets or masks were coded as undetermined, as well as individuals who it was not easy to make an assessment of their facial expression. Notable stereotypes by appearance are also noted. Tables 7, 8, and 9 show where scientists are being depicted in their images and to what extent they are alone or working with other scientists. Tables 10, 11, and 12 describe the types of activities scientists are shown engaging in, including DAST's symbols of research and knowledge. These tables' totals will not add up to prior totals since repeated images were counted. Notable stereotypes by type of activity are noted. Tables 4-12 redress research question two.

Table 1 shows coded results for sixth grade biology textbooks. Although nothing was significant, it is notable that there were differences by textbook publishers in the number of named scientists (e.g., Textbook 3 had 2.5 times fewer male and female scientists than Textbook 1). Scientists shown were overwhelmingly white with no Latin@ or Native American representation.

Table 1. Sixth Grade Biology Analysis of Naming and Demographic Information

	Textbook 1	**Textbook 2**	**Textbook 3**
Scientists' Being Named in Textbook			
Named Scientists	60	24	6
Double Pictures	0	3	0
Unnamed Scientists	22	46	28
Double Pictures	0	0	0
Apparent Race, Ethnicity, or Nationality			
Caucasian or White	56 (28) (28)	42 (24) (18)	24 (14) (9)
Named	43	11	2
Asian-American	10 (7) (3)	3 (1) (2)	4 (0) (4)
Named	7	2	1
African-American or Black American	10 (6) (4)	7 (4) (3)	3 (2) (1)
Named	9	1	3
Latin@ or Hispanic	4 (4) (0)	1 (1) (0)	1 (1) (0)
Named	1	0	0
Arab or Arabic	1 (0) (1)	0 (0) (0)	0 (0) (0)
Named	0	N/A	N/A
Native American or Pacific Islander	0 (0) (0)	0 (0) (0)	0 (0) (0)
Named	N/A	N/A	N/A
Non-U.S. (e.g., African, European)	15 (8) (7)	14 (13) (1)	0 (0) (0)
Named	15	9	N/A
Undetermined or Non-Binary	1	2	2
Gender Presentation			
Male	45	43	17
Named	33	15	3
Female	36	27	14
Named	28	9	3
Undetermined or Non-Binary	1	0	3
Chi Square Analysis of Gender x Being Named in Text			
Named males by unnamed males	33 x 12	15 x 27	3 x 14
Named females x unnamed females	28 x 9	9 x 19	3 x 11
Chi squared value	0.059	0.095	0.070
p-value	0.809	0.758	0.791
Science Occupation			
4-year: advanced degree	62 (33) (28)	45 (28) (17)	26 (13) (10), *3*
Named	47	16	6
2-year: associates, certification	12 (6) (6)	18 (11) (7)	7 (3)(4)
Named	5	1	0
Amateur: no formal training	6 (4) (2)	7 (4) (3)	1 (1) (0)
Named	5	7	0
Science-adjacent: jeweler	2 (2) (0)	0 (0) (0)	0 (0) (0)
Named	2	0	0
Fisher's Exact Test of Gender x Science Occupation			
4-year	33 x 28	28 x 17	13 x 10
p-value	0.609	0.135	0.678
2-year	6 x 6	11 x 7	3 x 4
p-value	1.226	0.481	1.000
Amateur	4 x 2	4 x 3	1 x 0
p-value	0.688	1.000	1.000
Science-adjacent	2 x 0	N/A	N/A
p-value	0.500	N/A	N/A

Table 2 has identified a similar issue as Table 1 in regard to differences by publisher and the lack of representation by indigenous people; white scientists comprised most (if not all) available images of scientists. There are significant differences in gender for the highest level science jobs, favoring images of men to women.

Table 2. Seventh Grade Earth Science Analysis of Naming and Demographic Information

	Textbook 1	**Textbook 2**	**Textbook 3**
Scientists' Being Named in Textbook			
Named Scientists	35	20	5
Double Pictures	3	2	0
Unnamed Scientists	17	28	11
Double Pictures	2	0	0
Apparent Race, Ethnicity, or Nationality			
Caucasian or White	31 (22) (7)	29 (19) (10)	10 (5) (4)
Named	18	5	4 (2) (2)
Asian-American	2 (1) (1)	3	0
Named	0	1	N/A
African-American or Black American	4	4	1
Named	4	3	0
Latin@ or Hispanic	3	0	0
Named	3	N/A	N/A
Arab or Arabic	0	0	0
Named	N/A	N/A	N/A
Native American or Pacific Islander	1	0	0
Named	1	N/A	N/A
Non-U.S. (e.g., African, European)	8	10	2
Named	8	9	1
Undetermined or Non-Binary	3	2	3
Gender Presentation			
Male	34	31	7
Named	24	15	3
Female	13	13	5
Named	11	4	2
Undetermined or Non-Binary	5	3	4
Chi Square Analysis of Gender x Being Named in Text			
Named males by unnamed males	24 x 10	15 x 16	3 x 4
Named females x unnamed females	11 x 2	4 x 9	2 x 3
Chi squared value	0.973	1.159	0.010
p-value	0.324	0.282	0.921
Science Occupation			
4-year: advanced degree*	40 (25) (10)	44 (29) (12)	16 (7) (5)
Named	28	19	5
2-year: associates, certification	3	2	0
Named	3	0	N/A
Amateur: no formal training	8	1	0
Named	3	0	N/A
Science-adjacent: jeweler	1	0	0
Named	1	N/A	N/A
Fisher's Exact Test of Gender (Male x Female) and Science Occupation			
4-year	25 x 10	29 x 12	7 x 5
p-value	**0.017****	**0.012****	0.774
2-year	2 x 1	2 x 0	0 x 0
p-value	1.000	0.500	N/A
Amateur	6 x 2	0 x 1	0 x 0
p-value	0.289	1.000	N/A
Science-adjacent	1 x 0	0 x 0	0 x 0
p-value	1.000	N/A	N/A

*Differences were due to people of undetermined gender and determinable science occupation.

Table 3 also displays differences by publisher and a lack of minority (non-White) representation. Men were portrayed in engaging in science hobbies significantly more than women.

Table 3. Eighth Grade Physical Science Analysis of Naming and Demographic Information

	Textbook 1	**Textbook 2**	**Textbook 3**
Scientists' Being Named in Textbook			
Named Scientists	41	12	13
Double Pictures	5	3	0
Unnamed Scientists	31	17	19
Double Pictures	1	1	0
Apparent Race, Ethnicity, or Nationality			
Caucasian or White	46 (23) (14)	18 (16) (2)	20 (9) (11)
Named	20	6	6
Asian-American	5	1	0
Named	2	0	N/A
African-American or Black American	5	3	3
Named	4	1	0
Latin@ or Hispanic	2	0	2
Named	2	N/A	1
Arab or Arabic	0	0	0
Named	N/A	N/A	N/A
Native American or Pacific Islander	0	o	0
Named	N/A	N/A	N/A
Non-U.S. (e.g., African, European)	13	5	7
Named	13	5	6
Undetermined	1	5	2
Gender Presentation			
Male	41	20	16
Named	25	10	8
Female	24	6	15
Named	16	2	5
Undetermined or Non-Binary	7	3	1
Chi Square Analysis of Gender x Being Named in Text			
Named males by unnamed males	25 x 16	10 x 10	8 x 8
Named females by unnamed females	16 x 8	2 x 4	5 x 10
Chi squared value	0.211	0.516	0.883
p-value	0.646	0.473	0.347
Science Occupation			
4-year: advanced degree	54 (29) (18)	18 (11) (4)	28 (15) (12)
Named	26	8	13
2-year: associates, certification	10	5	4
Named	7	1	0
Amateur: no formal training	7	6	0
Named	7	3	N/A
Science-adjacent: jeweler	1	0	0
Named	1	N/A	N/A
Fisher's Exact Test of Gender (Male x Female) and Science Occupation			
4-year	29 x 18	11 x 4	15 x 12
p-value	0.144	0.118	0.701
2-year	6 x 4	3 x 2	1 x 3
p-value	0.754	1.000	0.625
Amateur	5 x 2	6 x 0	0 x 0
p-value	0.453	**0.031***	N/A
S**cience-adjacent**	1 x 0	0 x 0	0 x 0
p-value	1.000	N/A	N/A

Table 4 shows that most scientists portrayed were older with significant differences in presenting middle aged men compared to their female peers. Scientists were either in casual or formal dress, donning mainly lab coats. Men were also significantly more likely pictured not smiling when working in their scientific tasks. There were 156 observations of a stereotypical scientist appearance and only two notations of mythical stereotypes.

Table 4. Sixth Grade Biology DAST Analysis of Scientist Appearance

	Textbook 1	Textbook 2	Textbook 3
Apparel			
Casual or Street Clothes	32	22	8
Nice Suit or Fancy Dress	30	19	6
Scrubs (Full or Partial)	3	13	3
Uniform (Military, Nurse, Ranger, etc.)	4	11	4
Field Clothing	6	1	1
Use of Personal Protective Equipment (PPE)			
Gloves, Mask, Eye, Ear, Head Protection	7	17	6
Lab Apron or Lab Coat[a]	16	10	14
Hazmat Suit	2	0	2
Clean Suit	0	0	0
Space Suit	1	0	0
Apparent Age			
Youth	2 (1)(1)	0 (0)(0)	0 (0)(0)
Adult to Middle Age	74 (42)(32)	68 (42)(23)	27 (13)(12)
Elderly	6 (3) (3)	6 (2)(4)	7 (4) (3)
Fisher's Exact Test of Gender (Male x Female) and Age			
Youth	1 x 1	0 x 0	0 x 0
p-value	1.500	N/A	N/A
Adult to Middle Age	42 x 32	41 x 23	13 x 12
p-value	0.295	**0.033***	1.000
Elderly	3 x 3	2 x 4	4 x 2
p-value	1.313	0.688	0.688
Facial Expression			
Smiling	42 (17)(24)	12 (3)(9)	6 (2)(4)
Not Smiling	36 (26)(9)	44 (28)(16)	23 (13)(10)
Undetermined[b]	5 (1)(0)	18 (13)(5)	5 (3)(1)
Fisher's Exact Test of Gender (Male x Female) and Facial Expression			
Smiling	17 x 24	3 x 9	2 x 4
p-value	0.349	0.146	0.688
Not-Smiling	26 x 9	28 x 16	13 x 10
p-value	**0.006****	0.096	0.678
General Scientist Appearance			
Eyeglasses	15	9	6
Facial Hair (beards and moustaches)	10	7	4
Tie (including bowties)	10	11	3
Mythical Appearance			
Light Bulbs	0	0	0
Pocket Protectors	0	0	0
Crazy Hair	1	0	1

Table 5, seven grade earth science displays scientists' appearance with several significant results. More men were pictures and of those men were significantly more likely to be middle aged or elderly. Again, scientists were half in formal and informal attire, with 10 instances of scientists in space suits. There were 48 observations of stereotypical scientist appearance and two mythical stereotypes.

Table 5. Seventh Grade Earth Science DAST Analysis of Scientist Appearance

	Textbook 1	Textbook 2	Textbook 3
Apparel			
Casual or Street Clothes	21	17	3
Nice Suit or Fancy Dress	13	16	2
Scrubs (Full or Partial)	0	0	0
Uniform (Military, Nurse, Ranger, etc.)	11	6	7
Field Clothing	11	8	2
Personal Protective Equipment (PPE)			
Gloves, Mask, Eye, Ear, Head Protection	4	13	3
Lab Apron or Lab Coat[a]	2	3	0

Hazmat Suit	1	1	0
Clean Suit	0	1	2
Space Suit	10	3	4
Apparent Age			
Youth	1 (1)(0)	0 (0)(0)	0 (0)(0)
Adult to Middle Aged	43 (24)(11)	44 (29)(12)	14 (7)(3)
Elderly	11 (10)(1)	5 (3)(2)	1 (1)(0)
Fisher's Exact Test of Gender (Male x Female) and Age			
Youth	1 x 0	0 x 0	0 x 0
p-value	1.000	N/A	N/A
Adult to Middle Age	24 x 11	29 x 12	7 x 3
p-value	**0.041***	**0.012****	0.344
Elderly	10 x 1	3 x 2	1 x 0
p-value	**0.012****	1.000	1.000
Facial Expression			
Smiling	23 (12)(10)	9 (4)(5)	5 (3)(1)
Not Smiling	21 (17)(3)	27 (20)(6)	5 (2)(3)
Undetermined[b]	12 (7) (1)	14 (3)(9)	6 (2)(1)
Fisher's Exact Test of Gender (Male x Female) and Facial Expression			
Smiling	12 x 10	4 x 5	3 x 1
p-value	0.832	1.000	0.625
Not-Smiling	17 x 3	20 x 6	2 x 3
p-value	**0.003****	**0.010****	1.000
General Scientist Appearance			
Eyeglasses	13	8	0
Facial Hair (beard, moustache)	11	4	1
Tie (including bowties)	7	4	0
Mythical Appearance			
Light Bulbs	0	0	0
Pocket Protectors	0	0	0
Crazy Hair	0	1	1

Table 6 shares the trend of formal and informal wear of scientists with the gloves, mask, etc. protection category with the most observations. Most scientists were middle aged with Men significantly more likely to be shown in this category. Men were also more likely to be shown not smiling overall and significantly so when compared to their female counterparts.

Table 6. Eighth Grade Physical Science DAST Analysis of Scientist Appearance

	Textbook 1	**Textbook 2**	**Textbook 3**
Apparel			
Casual or Street Clothes	23	8	7
Nice Suit or Fancy Dress	32	17	14
Scrubs (Full or Partial)	2	2	3
Uniform (Military, Nurse, Ranger, etc.)	9	3	3
Field Clothing	3	0	3
Personal Protective Equipment (PPE)			
Gloves, Mask, Eye, Ear, Head Protection	8	7	4
Lab Apron or Lab Coat[a]	6	4	6
Hazmat Suit	1	0	0
Clean Suit	8	0	0
Space Suit	1	2	2
Apparent Age			
Youth	1 (1)(0)	1 (1)(0)	0 (0)(0)
Adult to Middle Age	69 (38)(23)	26 (17)(5)	27 (12)(14)
Elderly	8 (5)(3)	7 (5)(2)	5 (4)(1)

Table 6. Continued

	Textbook 1	Textbook 2	Textbook 3
Fisher's Exact Test of Gender (Male x Female) and Age			
Youth	1 x 0	1 x 0	0 x 0
p-value	1.000	1.000	N/A
Adult to Middle Age	38 x 23	17 x 5	12 x 14
p-value	0.072)	**0.017****	0.845
Elderly	5 x 3	5 x 2	4 x 1
p-value	0.727	0.453	0.375
Facial Expression			
Smiling	22 (7)(15)	6 (5)(1)	10 (3)(7)
Not Smiling	44 (33)(10)	23 (18)(5)	17 (11)(6)
Undetermined[b]	13 (5)(1)	6 (1)(1)	5 (2)(2)
Fisher's Exact Test of Gender (Male x Female) and Facial Expression			
Smiling	7 x 15	5 x 1	3 x 7
p-value	0.134	0.219	0.344
Not-Smiling	33 x 10	18 x 5	11 x 6
p-value	**0.001*****	**0.011****	0.332
General Scientist Appearance			
Eyeglasses	1	4	1
Facial Hair (beards and moustaches)	1	3	1
Tie (including bowties)	1	4	1
Mythical Appearance			
Light Bulbs	0	3	0
Pocket Protectors	0	0	0
Crazy Hair	3	3	3

Table 7 shows the nature of collaboration among featured scientists, with biology-related careers being featured mostly indoors. There were some variations by the place in which scientists were pictured by the book publisher; textbook 1 had shown more field work, textbook 2 favored medical settings, and textbook 3 featured laboratory work. Only slightly more scientists were pictured alone than not, with the exception of textbook 3.

Table 7. Sixth Grade Biology DAST Analysis by Location and Collaboration

	Textbook 1	Textbook 2	Textbook 3
General Location			
Indoors	45 (23)(22)	37 (16)(21)	21 (11)(9)
Outdoors	27 (17)(8)	26 (15)(10)	11 (4)(4)
Undetermined	12 (6)(6)	12 (8)(4)	3 (2)(1)
Fisher's Exact Test of Gender (Male x Female) and Location			
Indoors	23 x 22	16 x 21	11 x 9
p-value	1.000	0.511	0.824
Outdoors	17 x 8	15 x 10	4 x 4
p-value	0.108	0.424	1.273
Specific Location			
Laboratory	17 (9)(8)	8 (3)(5)	13 (6)(7)
In the Field (includes Outer Space)	25 (16)(8)	23 (14)(9)	5 (2)(1)
Hospital (including Ambulances)	6 (2)(4)	30 (12)(18)	9 (4)(4)
Classroom (includes In/Formal Learning Spaces)	4 (2)(2)	0 (0)(0)	1 (1)(0)
Office or Conference Room	9 (6)(3)	1 (1)(0)	3 (2)(1)
Fisher's Exact Test of Gender (Male x Female) and Place			
Laboratory	9 x 8	3 x 5	6 x 7
p-value	0.999	0.727	0.999
In the Field	16 x 8	14 x 9	2 x 1
p-value	0.152	0.405	1.000
Hospital	2 x 4	12 x 18	4 x 4
p-value	0.688	0.362	1.273
Classroom	2 x 2	0 x 0	1 x 0
p-value	1.375	N/A	1.000
Office or Conference Room	6 x 3	1 x 0	2 x 1
p-value	0.508	1.000	1.000

Table 7. Continued

	Textbook 1	Textbook 2	Textbook 3
Working Alone or Collaborating with other People			
Pictured Alone	54 (24)(28)	39 (23)(16)	14 (6)(8)
Pictured with another Person	29 (18)(11)	35 (21)(14)	19 (10)(6)
Fisher's Exact Test of Gender (Male x Female) and Collaboration			
Pictured Alone	24 x 28	23 x 16	6 x 8
p-value	0.678	0.337	0.791
Pictured with Others	18 x 11	21 x 14	10 x 6
p-value	0.265	0.311	0.454

Table 8 shows the nature of collaboration among featured scientists, with earth scientists being featured outdoors. The variations to the place where scientists were pictured by book publishers with textbooks 1 and 3 showing more field work rather than mostly medical settings (textbook 2). Men were significantly more likely to be pictured outdoors and in the field. Only slightly more scientists were pictured alone than not, with the exception of textbook 3.

Table 8. Seventh Grade Earth Science DAST Analysis by Location and Collaboration

	Textbook 1	Textbook 2	Textbook 3
General Location			
Indoors	24 (13)(8)	17 (12)(5)	5 (2)(2)
Outdoors	31 (21)(6)	24 (14)(7)	8 (3)(2)
Undetermined	2 (1)(1)	9 (6)(3)	3 (20)(1)
Fisher's Exact Test of Gender (Male x Female) and Location			
Indoors	13 x 8	12 x 5	2 x 2
p-value	0.383	0.143	1.375
Outdoors	21 x 6	14 x 7	3 x 2
p-value	**0.006****	0.189	1.000
Specific Location			
Laboratory	8 (4)(2)	11 (5)(6)	5 (2)(2)
In the Field (includes Outer Space)	32 (21)(7)	24 (16)(5)	8 (3)(2)
Hospital (including Ambulances)	0 (0)(0)	0 (0)(0)	0 (0)(0)
Classroom (includes In/Formal Learning Spaces)	6 (5)(1)	4 (3)(1)	0 (0)(0)
Office or Conference Room	5 (3)(2)	1 (1)(0)	0 (0)(0)
Fisher's Exact Test of Gender (Male x Female) and Place			
Laboratory	4 x 2	5 x 6	2 x 2
p-value	0.688	1.000	1.375
In the Field	21 x 7	16 x 5	3 x 2
p-value	0.013	**0.027***	1.000
Hospital	0 x 0	0 x 0	0 x 0
p-value	N/A	N/A	N/A
Classroom	5 x 1	3 x 1	0 x 0
p-value	0.219	0.625	N/A
Office or Conference Room	3 x 2	1 x 0	0 x 0
p-value	1.000	1.000	N/A
Working Alone or Collaborating with other People			
Pictured Alone	39 (25)(12)	33 (20)(10)	10 (3)(3)
Pictured with another Person	18 (11)(3)	17 (12)(5)	6 (4)(2)
Fisher's Exact Test of Gender (Male x Female) and Collaboration			
Pictured Alone	25 x 12	20 x 10	3 x 3
p-value	**0.047***	0.099	1.313
Pictured with Others	11 x 3	12 x 5	4 x 2
p-value	0.057	0.143	0.688

Table 9 displays how most physical scientists were pictured indoors, but male scientists were significantly more likely to be the few seen outside. Similar trends in Tables 7 and 8 were found in the specific location of scientists, with men being more significantly featured in the field. Scientists were 1.5 times more likely to be pictured working alone.

Table 9. Eighth Grade Physical Science DAST Analysis by Location and Collaboration

	Textbook 1	**Textbook 2**	**Textbook 3**
General Location			
Indoors	48 (21)(20)	16 (8)(6)	20 (9)(11)
Outdoors	15 (13)(2)	12 (11)(0)	7 (3)(3)
Undetermined	14 (9)(5)	7 (5)(1)	5 (4)(1)
Fisher's Exact Test of Gender (Male x Female) and Location			
Indoors	21 x 10	8 x 6	9 x 11
p-value	0.071	0.791	0.824
Outdoors	13 x 2	11 x 0	3 x 3
p-value	**0.007****	**0.001*****	1.313
Specific Location			
Laboratory	24 (9)(8)	8 (4)(4)	11 (6)(5)
In the Field (includes Outer Space)	15 (10)(5)	11 (10)(0)	7 (3)(3)
Hospital (including Ambulances)	7 (4)(3)	4 (0)(2)	6 (2)(4)
Classroom (includes In/Formal Learning Spaces)	6 (4)(2)	2 (2)(0)	0 (0)(0)
Office or Conference Room	10 (6)(4)	1 (1)(0)	3 (1)(2)
Fisher's Exact Test of Gender (Male x Female) and Place			
Laboratory	9 x 8	4 x 4	6 x 5
p-value	0.999	1.273	1.000
In the Field	10 x 5	10 x 0	3 x 3
p-value	0.302	**0.002****	1.313
Hospital	4 x 3	0 x 2	2 x 4
p-value	1.000	0.500	0.688
Classroom	4 x 2	2 x 0	0 x 0
p-value	1.000	0.500	N/A
Office or Conference Room	6 x 4	1 x 0	1 x 2
p-value	0.754	1.000	1.000
Working Alone or Collaborating with other People			
Pictured Alone	48 (28)(19)	24 (17)(5)	20 (9)(9)
Pictured with another Person	31 (17)(8)	11 (7)(2)	12 (6)(6)
Fisher's Exact Test of Gender (Male x Female) and Collaboration			
Pictured Alone	28 x 19	17 x 5	9 x 9
p-value	0.243	0.017	1.186
Pictured with Others	17 x 8	7 x 2	6 x 6
p-value	0.108	0.180	1.226

Table 10 provides context to scientists portrayed in sixth grade biology, scientists with just a headshot; a headshot with items or background; a staged photo where the action was not real or authentic, and last, an image of a scientist engaging in real scientific activity, the latter of which was most observed. There were 30 observations of dangerous activity, 62 symbols of research using living specimens, followed by tools and equipment of biology and medicine respectively. Symbols of knowledge were fewer and varied by textbook publishers.

Table 10. Sixth Grade Biology DAST Analysis of Activity including Symbols of Research and Knowledge

	Textbook 1	**Textbook 2**	**Textbook 3**
Activity			
Headshot	15 (6)(9)	6 (4)(2)	3 (2)(1)
Items	26 (13)(13)	13 (9)(4)	2 (1)(1)
Staged	10 (5)(5)	9 (5)(4)	5 (3)(2)
Real	32 (22)(9)	46 (26)(20)	24 (11)(10)
Fisher's Exact Test of Gender (Male x Female) and Activity			
Headshot	6 x 9	4 x 2	2 x 1
p-value	0.607	0.688	1.000
Items	13 x 13	9 x 4	1 x 1
p-value	1.156	0.267	1.500
Staged	5 x 5	5 x 4	3 x 2
p-value	1.246	1.000	1.000
Real	22 x 9	26 x 20	11 x 10
p-value	0.029	0.461	1.000

Table 10. Continued

	Textbook 1	Textbook 2	Textbook 3
Hazardous activity			
Dangerous	7	10	13
Secretive	4	3	2
Causing Pain or Distress	4	0	2
Symbols of Research			
Specimens (Non-Living)	1	0	1
Specimens (Living), including Samples	25	27	10
Glassware/Vials	10	4	2
Chemicals	4	1	3
Manipulating a Model (Map/s)	4	0	2
Research or Data Presentation	1	0	2
Medical Tools and Equipment	8	26	8
Space-based Tools and Equipment	0	0	1
Science Tools and Equipment	12	9	0
Telescope	0	0	0
Microscope	4	3	0
Symbols of Knowledge			
Computer Software	1	1	1
Filing Cabinet/s	0	0	0
Identification (ID), Credential, Badge	1	1	2
Clipboard/s	2	1	0
Book/s and Textbook/s	4	1	3
Notebook/s and Notecard/s	3	6	1
Pen in Hand or Pen in Pocket	4	6	5
Background: Models, Posters, Chalkboard	9	3	1

Table 11 shows variation among textbook publishers to how scientists were shown engaging in science, with 49 coded as real. Men were significantly more likely to be seen with items and staged photos. Sixty-two symbols of research were living specimens followed by tools and equipment of science and space respectively. Symbols of knowledge were fewer and varied by textbook publishers. There were 31 observations of dangerous activity, 51 observations of scientific equipment followed by 35 observations of non-living specimen use.

Table 11. Seventh Grade Earth Science DAST Analysis of Activity including Symbols of Research and Knowledge

	Textbook 1	Textbook 2	Textbook 3
Activity			
Headshot	7 (3)(4)	7 (6)(1)	2 (1)(1)
Items	20 (15)(5)	3 (1)(2)	4 (2)(1)
Staged	12 (9)(2)	15 (12)(3)	3 (1)(1)
Real	17 (9)(4)	25 (13)(9)	7 (3)(2)
Fisher's Exact Test of Gender (Male x Female) and Activity			
Headshot	3 x 4	6 x 1	1 x 1
p-value	1.000	0.125	1.500
Items	15 x 5	1 x 2	2 x 1
p-value	**0.041***	1.000	1.000
Staged	9 x 2	12 x 3	1 x 1
p-value	0.065	**0.035***	1.500
Real	9 x 4	13 x 9	3 x 2
p-value	0.267	0.523	1.000
Hazardous activity			
Dangerous	10	16	5
Secretive	1	2	3
Causing Pain or Distress	0	0	0

Table 11. Continued

	Textbook 1	Textbook 2	Textbook 3
Symbols of Research			
Specimens (Non-Living)	14	17	4
Specimens (Living), including Samples	2	7	3
Glassware/Vials	2	0	0
Chemicals	1	1	0
Manipulating a Model (Map/s)	2	2	0
Research or Data Presentation	1	0	0
Medical Tools and Equipment	0	0	0
Space-based Tools and Equipment	12	5	6
Science Tools and Equipment	21	24	6
Telescope	1	1	0
Microscope	0	2	0
Symbols of Knowledge			
Computer Software	3	4	0
Filing Cabinet/s	2	0	0
Identification (ID), Credential, Badge	0	0	0
Clipboard/s	0	3	1
Book/s and Textbook/s	2	0	1
Notebook/s and Notecard/s	3	3	0
Pen in Hand or Pen in Pocket	3	1	0
Background: Models, Posters, Chalkboard	6	2	1

Table 12 shows similarity among textbook publishers to how scientists were shown engaging in science, with 44 coded as real and 42 with items. Men were significantly more likely to be seen in real photos than women. There were 16 observations of dangerous activity and 12 of secretive behaviors. Fifty-five symbols of research were observed using scientific equipment. Symbols of knowledge were fewer than all other grade levels and content areas.

Table 12. Eighth Grade Physical Science DAST Analysis of Activity including Symbols of Research and Knowledge

	Textbook 1	Textbook 2	Textbook 3
Activity			
Headshot	14 (9)(5)	6 (5)(1)	7 (5)(2)
Items	28 (14)(10)	12 (10)(1)	2 (1)(1)
Staged	15 (6)(6)	7 (3)(3)	11 (5)(6)
Real	22 (16)(6)	10 (6)(2)	12 (5)(6)
Fisher's Exact Test of Gender (Male x Female) and Activity			
Headshot	9 x 5	5 x 1	5 x 2
p-value	0.424	0.219	0.453
Items	14 x 10	10 x 1	1 x 1
p-value	0.541	0.012	1.500
Staged	6 x 6	3 x 3	5 x 6
p-value	1.226	1.313	1.000
Real	16 x 6	6 x 2	5 x 6
p-value	**0.050***	0.289	1.000
Hazardous activity			
Dangerous	5	6	5
Secretive	5	2	5
Causing Pain or Distress	1	2	1
Symbols of Research			
Specimens (Non-Living)	5	1	2
Specimens (Living), including Samples	4	1	0
Glassware/Vials	5	3	7
Chemicals	5	3	3
Manipulating a Model (Map/s)	6	1	2
Research or Data Presentation	1	0	0
Medical Tools and Equipment	7	3	5
Space-based Tools and Equipment	9	2	3
Science Tools and Equipment	24	20	11
Telescope	0	0	0
Microscope	1	1	0

Table 12. Continued

	Textbook 1	Textbook 2	Textbook 3
Symbols of Knowledge			
Computer Software	2	1	3
Filing Cabinet/s	1	0	0
Identification (ID), Credential, Badge	2	0	1
Clipboard/s	2	0	1
Book/s and Textbook/s	4	0	1
Notebook/s and Notecard/s	2	0	0
Pen in Hand or Pen in Pocket	2	0	0
Background: Models, Posters, Chalkboard	4	3	0

Discussion

Salient and significant findings suggest that among the major middle grade science textbooks, across biology, earth and physical science, largely present images of scowling older solitary white males in a stereotypical manner (i.e., appearance, activities). Further, women and minority scientists have significantly less representation in all texts, echoing the findings of research of scientists' images in undergraduate science textbooks (Simpson et al., 2021; Wood et al., 2020). That being said, women were found as named and unnamed scientists within science textbooks, which may help to explain why girls' drawings of female scientists have been significantly risen since the 1950s (Mead & Metraux, 1957) and into the first two decades of the new millennium (Finson et al., 2017; Narayan et al., 2009). Further, scientists are shown engaging in scientific activity with PPE, suggesting to students that scientists exercise caution when engaging in scientific endeavors. Research on the public's perceptions of PPE use during the COVID-19 pandemic found significant associations between PPE and responsible safety measures (e.g., Simpson, & Sandrin, 2021); therefore, these portrayals of scientists wearing PPE are likely to help eschew students' notions of the uncontrollable and irresponsible *mad scientist.* Such depictions may help to explain affirming literature that suggests mythical stereotypes have receded over time among students' perceptions of scientists (Bozzato et al., 2021; Finson, 2002; Hillman et al., 2014).

It is worth to note that symbols of research (e.g., specimens and equipment) were more observed more often than symbols of knowledge (e.g., computers and notebooks), which is a common finding among most DAST-based research (Ferguson & Lezotte, 2020) Frequency counts, of the demographic attributes of scientists that were coded varied greatly across textbook publishers. Research by Good et al. (2010) found that texts that contained non-stereotypical images of scientists (women scientists) improved female students comprehension of said text when compared to reading the same texts with stereotypical imagery (male scientists). This finding from the present study, coupled with Good et al.'s (2010) research, should be a staunch warning to textbook manufacturers to be mindful of who they present to students as scientists and how that can differentially impact female students. Not all is bleak; one salient finding in Tables 10-12 related to the context of scientists' photographs. Notably, across all three grade levels and three content areas, scientists were shown as engaged in authentic scientific activity. Scholars have found that when students' perceive science and scientists as being part of an active enterprise, they are more inclined towards engaging in science at school (Lei et al., 2019) and as a future career (Narayan et al., 2013). In sum, images of scientists from the sampled textbooks provide an improved view of scientific endeavor while retaining traditional notions of who (i.e., older, white males) are scientists. This is important since "current science textbooks make a concerted effort to depict scientists as females and ethnic minorities; [yet] students most often depict scientists as white males" (Monhardt, 2003, p. 27). Given that Takach and Yacoubian (2020) found that students' perceptions of scientists mirrored those found in the science textbooks that they use, this study adds to the call for more diverse and inclusive images of scientists in science textbooks, especially during the formative years of adolescent development (i.e., middle grades) to cease the cycle of internalizing stereotypical ideas and views of scientists.

Conclusion

This research adds to the ongoing, rich, and robust literature on sources of students' perceptions of scientists. By examining middle grade textbooks, this work provides insight to how images in science textbooks poorly represent diverse scientists, have gendered attributes of scientific activities, contain specific DAST-based elements of negative scientist tropes (e.g., danger, secrecy), and limited portrayals of symbols of knowledge. The purpose of this ongoing research in students' perceptions of scientists helps to address the concerns of the National Science Teachers (now Teaching) Association recommended back in 1992 the reformation in images of science and portrayals of scientists in formal science materials (as cited in Monhardt, 2003). Because many pre-service and in-service science teachers utilize content from textbooks for their curriculum and instruction, it is important that textbook publishers and teachers alike develop a greater awareness of the power of these images and strive to provide the most positive portrayals of scientists and their work for middle grade students. Further, this research adds to the greater understanding of how images of scientists in textbooks can influence students, especially girls, by either contributing to or mitigating negative perceptions (stereotypes) of scientists during their formative middle grade years of schooling.

Recommendations

In light of the present study's findings, textbook publishers can use DAST-C as a summative tool to self-assess the types of images they have in extant textbooks and formative tool to ensure a diverse set of images, showing named scientists engaged in authentic work with tools in a variety of settings, such to not incidentally introduce negative stereotypes of scientists to adolescent science learners. For researchers, this study has identified avenues of interest to explore more deeply in regard to how scientists are portrayed in science textbooks. For example, the physical science textbook sampled contained scientists engaged in more secretive activities (as compared to biology and earth science texts). Also, the wide variation among publishers to how science is presented presents interesting issues of equity and access. Depending on a student's location and the nature of local/state textbook contracts, entire swaths of students may have a limited view of (and access to) images of scientists, contributing to a myopic view of the diversity and activity seen in DAST analyses. For example, would students who use textbook 3, with fewer elements of scientist and scientists hold different perceptions (stereotypes) of scientists compared to students who use textbooks 1 and 2? This question could potentially be studied at scale given there is traceable use of specific textbooks across states and regions. Such research would help to address limitations in prior work by Finson (2002) and to better understand how these images influence students' perceptions of science and scientists.

Limitations

Because of the survey-based nature of this research, images were coded for attributes of DAST-C to create an overview of how scientists were portrayed in science textbooks. More in-depth analyses with DAST-C can be conducted, for each scientist photograph, to calculate a mean DAST-C value. Such values can be compiled for each textbook, establishing a DAST-C mean for all textbooks within a grade level, subject area, and textbook publisher. To better quantify stereotypes, DAST-C scores below 3.0 indicate that fewer stereotypes are present, demonstrating a more inclusive and realistic view of science and scientists.

Acknowledgements

Thanks to Lindsay Wargo and Carolanne Grogan in helping refine the DAST coding and codebook respectively.

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Appendices

Appendix A: Codebook per DAST, DAST-C and m-DAST Frameworks

Appearance:

• Fancy Suit or Clothes	**Lab Coat (what under the coat?)**
• Casual or Street Clothes	Gloves
• Uniform (Flight suit, etc.)	Mask
• Field Clothes (like Ecologist)	Eye protection (safety glasses/goggles)
• Full Scrubs (surgical)	Ear protection
• Partial Scrubs (nurse)	Bouffant Cap, Helmet
• Hazmat Suit (respirator)	*If nothing other than lab coat is specified, than you could not tell what was under lab coat from picture.*
• Clean Suit (bunny suit)	
• Space Suit (full gear)	

Sites:

Laboratory (Lab)	Office	Field (includes OUTER SPACE)
Hospital (includes Ambulances)		Classroom (Formal & Informal (Museums, Studios))
Cannot Tell (Headshot)		

Stereotypes:

Crazy Hair	Facial Hair (beard, moustache)	Tie (includes bowties)	**Eye glasses!**
Light bulbs	Pocket Protector	Mad scientists look	Asian
Dangerous Activity • heavy PPE, sparks flying, • dangerous animals or work environments		Secretive Activity • Working in Secret (Signage, etc.) • Human or animal subject (or patient) is in pain or distress	

Symbols of Research:

Specimens (Living) (Microorganisms, Bacteria, Viruses, Plant/Animal Cells)	Science Tools and Equipment (anything including measurement, should be identified in **Tech Section**)
Specimens (non-Living) (Rocks, Bones, Fossils, Gems, Dirt, Water)	Manipulating a Model (Maps)
Human Samples (Hair, Skin, Teeth, Nails, Saliva, Semen)	Space Equipment
Glassware/Solutions/Vials	Medical Equipment
Chemicals* (e.g. vaccines, ether, etc.)	Research or Data Presentation
Telescope	Microscope

Symbols of Knowledge:

Computer Software	Clipboard/s	Pens in hand	*Background stuff*: Models in background (Chalkboards), Lab coats hanging up, Posters on the wall
Filing Cabinet/s	Textbook/s	Pens in pocket	
Badging (IDs)	Notebook/s & Notecards	Book/s	

Technology Present:

Computers	Sound equipment (headsets)	Camera/Photography
Communication Technology (Cellular/Mobile Phones, Pagers)	Physiologic Sensors	Surveillance Technologies

Appendix B. Location of Scientists within Each Textbook Sampled by Publisher

	Textbook 1 Holt	**Textbook 2** Prentice Hall	**Textbook 3** Glencoe
Location Scientists' Images Among Sixth Grade Biology Textbooks			
Text Reading	26	43	16
Unit Introduction and Timelines	22	20	0
Special Section (of four parts below)	35	11	14
Interdisciplinary	0	2	7
Highlighting a Scientist	22	2	1
Science Careers	13	6	0
Other Sections (General Science)	0	1	10
Page Numbers (Mean)	299.89	395.04	346.89
Page Numbers (Median)	241	465	202
Page Numbers (Mode)	7, 110, 145, 219, 222, 577	593	31, 586, 660
Location Scientists' Images Among Seventh Grade Earth Science Textbooks			
Text Reading	18	36	12
Unit Introduction and Timelines	9	8	0
Special Section (of 4 parts below)	30	6	4
Interdisciplinary	0	1	3
Highlighting a Scientist	17	0	0
Science Careers	13	5	0
Other Sections (General Science)	0	0	1
Page Numbers (Mean)	324.27	334.85	492.65
Page Numbers (Median)	297	346.5	641.5
Page Numbers (Mode)	712	17, 703	644
Location Scientists' Images Among Eighth Grade Physical Science Textbooks			
Text Reading	27	22	13
Unit Introduction and Timelines	21	5	0
Special Section (of 4 parts below)	31	5	19
Interdisciplinary	0	3	9
Highlighting a Scientist	12	0	2
Science Careers	19	2	0
Other Sections (General Science)	0	0	8
Page Numbers (Mean)	336.66	382.89	430.19
Page Numbers (Median)	333	362	495
Page Numbers (Mode)	115	362	13, 492, 498, 769