Using the Draw-a-Scientist Test for Inquiry and Evaluation

By Eleanor Miele

The Draw-a-Scientist Test (DAST) is a tool to assess stereotypical imagery of scientists. This paper describes the use of the DAST as both a model for inquiry and as a method of assessing the affective domain. The DAST was administered in a science education methods course for undergraduate students of elementary education, a methods course for graduate students specializing in elementary science education, and a science content course for early childhood teachers. The DAST was used to model data collection and analysis and to increase education majors' awareness of their own stereotypical images of scientists. DAST results at the end of the semester showed a reduction in stereotypical imagery of scientists and an increase in images of women, teachers, and children and in other nonstereotypical images of people doing science. Graduate students specializing in elementary science view scientists more inclusively than do undergraduate elementary education majors. The DAST can be a useful tool in college science classes to assess the effectiveness of instructional approaches aimed at fostering identification with people who do science.

The majority of elementary school teachers avoid teaching science (Tilgner, 1990). A major goal of courses in science for teachers should be to help them develop enthusiasm for science and science teaching. If changes in the affective domain are major goals of courses in science, end-of-course evaluations should assess these changes. The Draw-a-Scientist Test (DAST) has been widely used for decades to examine, analyze, and evaluate students' and teachers' perceptions of scientists (Finson, 2002; Finson & Pedersen, 2009).

This study uses the DAST to meet four distinct goals of courses in teaching science for elementary educators. The first goal was to provide practice in doing inquiry-based science through data collection and analysis. The second goal was to reveal common stereotypes of scientists and their implications for teaching science. The third goal was to self-assess changes in imagery to help current and future teachers reexamine their beliefs. The fourth goal was to evaluate whether the course met the goal of helping teachers identify with scientists as real people like themselves.

The Draw-a-Scientist Test

Chambers first introduced the DAST in 1983 as a nonverbal tool to assess children's images of scientists. The DAST asks participants to "draw a picture of a scientist doing science." Chambers (1983) identified seven "standard" characteristics of children's drawings: lab coat, eyeglasses, facial growth of hair, symbols of research (beakers), symbols of knowledge (books), products of science (rockets), and captions ("eureka").

To increase the objectivity and reliability of the DAST as an assessment instrument, Finson, Beaver, and Cramond (1995) developed the Draw-A-Scientist Test Checklist (DAST-C) where each item represents a standard stereotypic characteristic. The DAST-C identified eight additional "alternative" characteristics including male gender, Caucasian, indications of danger, lightbulbs, mythic stereotypes (mad-crazed, Frankenstein), indications of secrecy, working indoors, middle aged or elderly. Using this version of the DAST, they analyzed pretests, posttests, and delayed posttests to demonstrate a significant shift ($p < .0001$) to more realistic images of persons involved in science among middle school students who had extended contact with diverse real-life scientists compared with control students who did not have this exposure.

The stereotypical image of a scientist as an old Caucasian male with wild hair wearing glasses and a lab coat and working alone in a laboratory has since been shown to be widely held among elementary school children (Barman, 1996) and to continue through high school (Rahm & Charbonneau, 1997). These limiting stereotypes of scientists remain prevalent and persistent among future teachers (McDuffie, 2001) and negatively impact teaching (Rosenthal, 1993). Moseley and Norris (1999) found that preservice early childhood and elementary education majors did not recognize that their stereotypical perceptions could negatively impact their teaching, whereas graduate students and students of secondary (sci-

ence) education expressed disappointment in their stereotypical images.

Goals 1 and 2: Practicing inquiry and recognizing stereotypes

In this study, the original Chambers's DAST was administered on the first day of an undergraduate class in methods of teaching elementary school science. A 50-minute class session was devoted to taking and analyzing the DAST to model authentic investigation using science process skills. Student drawings were used to generate data to create a collaborative class bar graph of the frequency of each stereotypical image among the class responses. Each student evaluated his or her own drawings for the presence of each stereotype, avoiding the need to interpret the intentions of the artist. The creation of a class bar graph of common stereotypes of scientists provided a focus for discussion of dependent and independent variables; categorical and quantitative variables; and general review of the conventions of graphing to organize, analyze, and represent data. At the end of class, students were invited, but not required, to contribute their unsigned drawings for use in this study.

The stereotypical characteristics of scientists identified by preservice teachers in this class included the following: male gender, eyeglasses, "wild" hair, pocket protector, lab coat, Caucasian race, old age, symbols of research such as beakers and flasks, and captions such as "*Eureka*" and "$e=mc^2$" (Figure 1). The images included men with "googly" eyes, iconic shorthand representing the mythic "mad scientist." The class then collaboratively calculated both the fraction and the percentage of students who subscribed to each stereotype. The data analysis answered the question: "What is the frequency of stereotypical ideas about scientists among students of education in this class?" The overwhelming majority of the images were White (95%) males (90%) with wild hair (71%) in lab coats (71%) and wearing eyeglasses (81%), in percentages remarkably similar to those seen among middle school students by Finson et al. (1995). Many of the images represented real persons such as Albert Einstein, television science personalities, or former high school and college science teachers that fit the common stereotype.

FIGURE 1

Typical Einstein imagery.

Fewer stereotypes among science specialists

In this study the DAST was also administered to 13 graduate students enrolled in a master's program focusing on elementary school science and environmental education. Many of these graduate students were already working in urban settings as elementary school science specialists or as educators teaching children at informal science institutions such as museums or zoos and thus worked in ethnically and racially diverse environments in which science instruction was a priority. They regularly "did science" with children. It may be inferred that teachers who self-select to be science specialists in elementary schools or science-rich cultural institutions see science as something that they can do and that their students can do. This was supported by the results of the DAST in this population.

Stereotypical imagery was less prevalent for every standard stereotype in the graduate students' drawings. Only 53% drew a person identified as older compared with 67% of undergraduates. They drew fewer White (66% vs. 95%) males (70% vs. 90%) with wild hair (47% vs. 71%) in lab coats (53% vs. 71%) and wearing eyeglasses (77% vs. 81%), with the difference between graduate science specialists and undergraduates most pronounced in the attributes of White, male, and wild hair. Although some of the differences approached statistical significance, given the small sample size, none reached the 95% confidence interval. In contrast to the drawings of undergraduates, many of the graduate students' drawings were of personal role models held in high esteem ("my aunt the scientist," "my high school mentor," "my student scientists") rather than of iconic scientists, real or imaginary such as Albert Einstein or "Dr. Frankenstein."

Awareness of the implications of limiting stereotypes

Moseley and Norris (1999) reported that their students were unaware of the implications in classroom practice of their limiting stereotypes of scientists. McDuffie (2001) found that when students of education were asked to write an essay summarizing the group's perceptions of scientists after informally quantifying the prevalence of stereotypical characteristics in their DAST tests, they expressed greater awareness of the implications of their stereotypes.

In this study, both the undergraduate and graduate classes recognized the implications of the limiting stereotypes revealed in the initial DAST results. Both classes engaged in thoughtful discussions about the implications of their stereotypes for urban teachers. They identified films, comics, books, and television (ironically this included educational television) as factors that reinforced their

own stereotypes of scientists. The undergraduates expressed pointed awareness that their drawings reflected images that excluded females, young people, and people of color and that their images did not reflect the average sex or complexion of their class or of the classes that they expected to teach. Time spent in class reflecting on the data as it was collected, discussed, and graphed may have afforded the opportunity for these students to develop their own ideas about the implications of the results of the DAST test.

Goal 3: Self-assessment of changes in imagery

The undergraduate students were asked to draw their image of a scientist once again during the last session of the semester. Informal quantification with a show of hands revealed a substantial reduction in characteristics that could be interpreted as exclusive (male, old, wild haired or crazy looking, using arcane tools or symbols of science) and an increase in characteristics that are more inclusive (young, female, using simple, widely accessible tools of science and natural objects, positive captions). Students engaged in a discussion that expressed enthusiasm about science and science teaching. Many students commented that they had become more confident in their ability to teach science and some commented that they had finally begun to feel that they could "do science." Students verbally identified their images as of "you," "me," "students," "teachers," and "my sister." Some drawings included captions that clarified and emphasized positive and inclusive attributes of the drawings—for example, captions included these comments: "my favorite scientist, my little sister," "science is fun," "*Blues Clues*" (an early childhood educational science program), "could be a man or a woman." Students expressed pride in how much their perceptions had changed.

Goal 4: Posttest DAST results indicate changing imagery

Results of a binomial logistic regression analysis show that the posttest drawings were much less likely to indicate an old person, a male, or wild hair ($p < .001$). Although initial drawings were 90% males, at the end the majority of drawings were of females (an increase of from 10% to 71%). Students' images of scientists more closely resembled themselves (this class, like most elementary education classes, was almost completely young women). The number of scientists identified as "old" was reduced from 67% to zero. Making an adjustment for the zero value, this result is significant at the $p < .001$ level. The number of images with wild hair was reduced from 71% to 14% ($p < .001$). Drawings completed after the class were also less likely to have figures with eyeglasses, with the number of such images reduced from 81% to 48% ($p = .014$). None of the drawings included googly eyes. Several drawings included an image identified as a child.

One persistent stereotype was of scientists as largely White (this actually increased from 95% to 100%). Another persistent stereotype was of scientists wearing eyeglasses, which reduced from 81% to 42%. Although this represents a significant difference ($p = .014$), the reduction was less than that seen in representations of males, older persons, or people with wild hair ($p < .001$). One factor contributing to the persistence of both of these stereotypes in the posttest is that several students reported that they drew an image of the author (a female research biologist turned teacher educator) who happens to be White and to wear glasses.

Images of scientists working collaboratively

Both Barman (1996) and McDuffie (2001) pointed out that students and teachers almost never included other people in their drawings of scientists at work. Teachers' sketches generally do not depict scientists as collaborators. This may reflect a literal response to the instructions to "draw *a* scientist doing science," perhaps creating an inherent bias to images of solitary scientists. In this study, 14% of the posttest DAST drawings (up from 0%) showed two or more individuals working together. This implies that these students' emerging vision of scientists as collaborators may transcend a literal interpretation of the instructions. One student drew her collaborative group from class, captioning it "my table/crew/classmates." Another student drew an adult with children, and still another drew children working together.

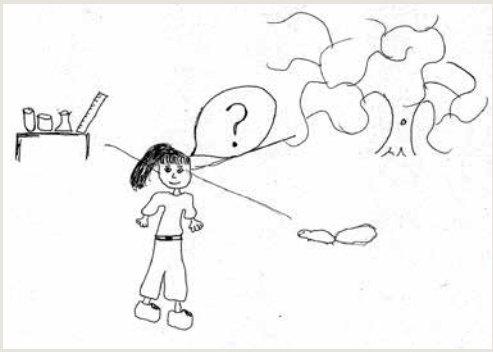
Changes in images of scientists' working environments and tools

Finson and colleagues found that over 95% of middle school students drew a scientist working indoors. Although not identified by students as a stereotype, all of the pretest drawings in this study showed a scientist working indoors. Many of the posttest drawings showed more fully developed and more accessible environments, including outdoors in parks and school yards (an increase of from 0% to 43%) and classrooms (an increase of from 0% to 14%; Figure 2). Drawings included images of nature, such as common local wild animals and plants.

Most of the second DAST drawings included tools of science (an increase of from 24% to 67%). Because the instructions for the DAST ask students to "draw a scientist doing science," the prompt biases the results to include tools of science to illustrate the "doing." It is surprising that so few of the initial drawings included tools given the instructions. Tools typically drawn in the first DAST were beakers and microscopes. Many of the tools depicted in the second DAST were simple tools of science used in elementary school

FIGURE 2

A young female scientist outdoors.



classrooms, including primer balances and common measuring devices such as rulers, thermometers, clocks, and graduated cylinders that had been used in class over the course of the semester. The increase in depiction of tools of science in the second DAST may reflect an increased familiarity with what those tools may be or an increased perception of the importance of science processes. These images of tools of science reflect an inclusive view of science as a process accessible to teachers and students.

Continuing change in imagery with increased inquiry experience

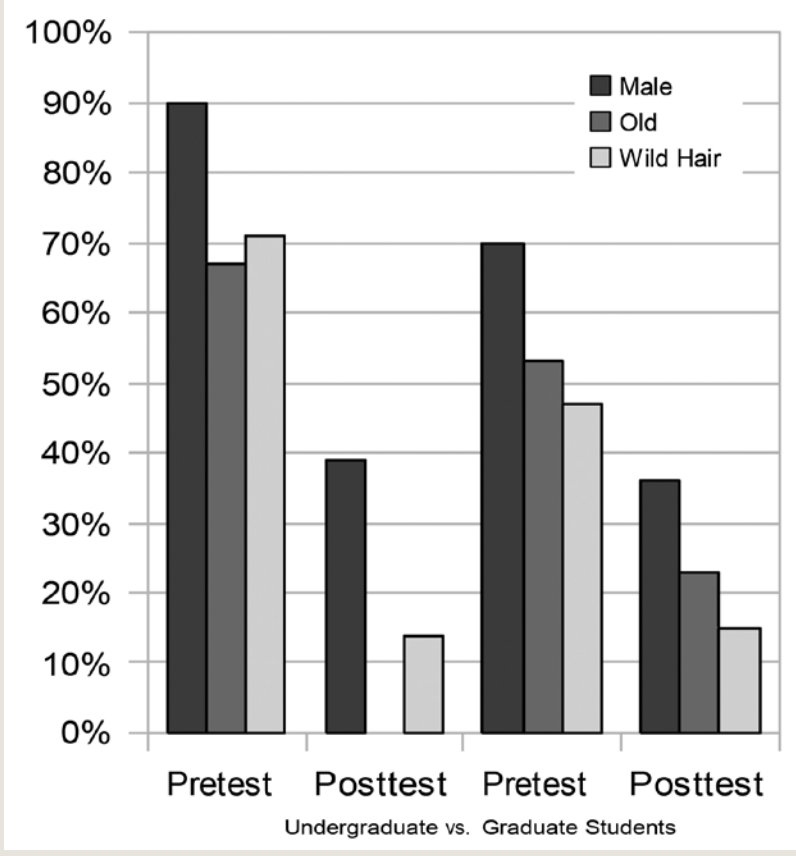
The DAST was also repeated at the end of the semester with the graduate students in childhood science and environmental education. These students, who began the semester with fewer stereotypes than typical undergraduate students of education, showed a further reduction in the frequency of stereotypical imagery in the end-of-semester DAST (Figure 3). As with the undergraduates, drawings after the course were much less likely to depict a scientist with wild hair, old age, or male gender ($p < .001$). There was no significant difference between the graduates and undergraduates in reduction in these stereotypes. Graduate students' representations of males reduced from 70% to 46%, representations of wild hair reduced from 47% to 15%, and representations of older persons reduced from 53% to 23%. The change in percentage of images that were of White scientists (69% to 62%) and wearing glasses (77% to 69%) were not significant, but this group began the semester with fewer stereotypes in these categories. The percentage of images that were of "real people" increased from 36% to 61%. These results indicate that ongoing participation in a community of inquiry-based science learners results in continual reduction in stereotypical imagery and increasing identification with scientists as real people.

Assessment of an inquiry-based science content course

The DAST was also administered at the end of an undergraduate inquiry-based science content course paired with a field-based course in methods of teaching science for students of early childhood education. Students were asked to draw a scientist doing science during the final session of the semester-long class in science content and were asked to write comments on the back of their drawings answering two questions: "Why did you choose to draw this person doing science?" and "What do you think you would you have drawn on the first day of class?" These students' drawings also showed less stereotypical imagery of scientists, and their comments

FIGURE 3

Change in selected stereotypical imagery in undergraduates versus graduates.



revealed that their images were substantially different than they would have been before taking these paired courses.

Twelve of the 18 students reported by a show of hands that they think they would have drawn Albert Einstein on the first day of class. One student, exemplifying the class, wrote on her paper, "I would've probably drawn my own interpretation of Einstein because he is the first 'scientist' who pops into my head. Glasses, crazy hair, very stereotypical." Another student who drew a child wrote, "This is a drawing of an everyday student/child. They are natural scientists who are inquiring about, and observing the world around them constantly." She went on to say,

> This image is definitely not the same thing I would have drawn on the 1st day of class. I probably would've drawn a male figure w/ crazy hair and glasses wearing a lab coat holding a beaker b/c that is what I believe the general perception of a scientist was prior to this semester.

Of the 18 end-of-class drawings, only seven (39%) were identified as male, only four (22%) showed wild hair. Eyeglasses and lab coats appeared in only 50% of the drawings. One student drew herself, and two students drew children. Three drew one of their science education professors from this semester. One student, whose drawing was of a classic stereotypical scientist with labels showing "wacky hair," "glasses," "mustache," "lab coat" (with name "Dr. Mad"), and "coat too short," explained why she drew this image:

> I drew this scientist because as younger I always had this thought of a scientist. I think of Albert Einstein and Dr. Frankenstein. I know that this is not the image of a scientist today. Anyone can be a scientist. Young children are great scientists because they are constantly learning, observing and exploring new things.

One student wrote, "I drew a marine scientist. I chose to draw this because these people are out in the field collecting data which is outside the realm of what we traditionally associate with scientists." Ten of 18 students reported by a show of hands that they drew a tool of science used in class during the semester.

These results indicate that the DAST may also have value as an evaluation tool for the affective domain when used only at the end of the semester.

Implications in practice for teacher educators

The DAST is a simple and easy (and fun) evaluation tool that can help teachers develop inquiry skills and valuable insights. The results of this study indicate that the DAST may be a useful tool to reveal changes in beliefs about science and scientists (and by inference, the effectiveness of instructional practices aimed at the affective domain) on completion of college courses in science and science education. The DAST drawings at the end of the semester showed that the preservice teachers had begun to view themselves and children as scientists and that inservice science specialists increasingly viewed themselves, their peers, and their students as scientists. These changed beliefs may contribute to changed practice. These beginning teachers, with their new, more inclusive image of scientists, may be more likely to join the minority of elementary school teachers who actually teach science. ■

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