



## PICTURE A SCIENTIST—DIVERSE ROLE MODELS SHOW THAT SCIENCE IS FOR EVERYONE

Samantha Wynns<sup>1\*</sup>, Clara L. Meaders<sup>2\*</sup>, Jaye C. Gardiner<sup>3</sup>, Sankalp Nigam<sup>4</sup> and Jillian Harris<sup>5</sup>

<sup>1</sup>Cabrillo National Monument, San Diego, CA, United States

<sup>2</sup>Department of Cell and Developmental Biology, School of Biological Sciences, University of California, San Diego, San Diego, CA, United States

<sup>3</sup>Cancer Signaling and Epigenetics, Fox Chase Cancer Center, Philadelphia, PA, United States

<sup>4</sup>School of Biological Sciences, University of California, San Diego, San Diego, CA, United States

<sup>5</sup>Department of Biology, Xavier University of Louisiana, New Orleans, LA, United States

### YOUNG REVIEWERS:



MAE  
AGE: 14



TOBY  
AGE: 12

Who do you picture when you think of the word “scientist”? Do you fit that image? Although science should be for everyone, some groups, including girls, people of color, the LGBTQ+ community, people with disabilities, and more are often discouraged from becoming scientists. Research shows that girls in particular start to lose interest in pursuing science careers during middle school. But part of the problem for every group is that you cannot be what you cannot see. So how do we change who students picture as scientists? We tested whether a playful STEAM (science, technology, engineering, art, math) program that uses comic books, trading cards featuring a variety of female role models, games, and outdoor exploration could change students’ minds. Our data shows that after the In Their Eyes: Conservation + Comics program, more students think that girls can be scientists, too!

## PSYCHOLOGY

The field of science that studies human minds and behaviors.

## COGNITIVE SCIENCE

The field of science that studies specific processes in the brain, like memory, perception, and language.

## COGNITION

The mental action or process of gaining knowledge and understanding through thought, experience, and the senses.

## SELF-CONCEPT

The image we have of ourselves and our behaviors.

## ROLE MODELS

People looked up to by others as examples to be imitated.

## DIVERSE

Very different or variety. In this context, people from a range of different social and ethnic backgrounds and of different genders, sexual orientations, etc.

## LEARNING, BELIEF, AND IDEAS ABOUT WHO CAN BE A SCIENTIST

Picture a scientist: who do you imagine? Go ahead and draw your scientist on a piece of paper or in a journal. Once you are finished, put your pencil down and read on. We will come back to your drawing later.

Have you ever wondered how you know what you know? How does your brain understand that, by combining certain letters together, you spell a specific word? Or how do you know how to make a bowl of cereal in the morning? Have you ever wondered why you think the way you do? Scientists in the fields of **psychology** and **cognitive science** are working hard to answer questions like these. They study something called **cognition**, which is the process of learning and understanding through thought, experiences, and using the senses (touch, taste, sound, smell, sight, kinesthetic, proprioceptive, etc.). Humans know what they know because of cognition, and our brains use various cognitive processes to help us understand ourselves and the world around us. Some examples of cognitive processes are solving problems, making decisions, or using memory [1]. The processes used by our brains to learn things like math or language are different than the brain processes used to form the beliefs we hold about ourselves—these beliefs are called our **self-concept**.

Science shows us that there is a link between people's self-concepts and who they grow up to be [2]. How do we know what we can be if we never see anyone like us doing the job? How do we believe we belong somewhere without **role models** that we identify with? One area of scientific study involves people's beliefs about who can be a scientist. Historically, only white men were allowed to be scientists and women, people of color, individuals with disabilities, and other minority groups (like people in the LGBTQ+ community) were intentionally excluded from science [3]. This caused two problems: first, there were very few scientists who were *not* white and male; and second, because there was a lack of **diverse** scientists, the *belief* that a person must be white and male to be a scientist was reinforced. In other words, there were very few diverse scientific role models, which reinforced people's beliefs that women, people of color, and others did not belong in science.

We wanted to see if providing diverse scientific role models to students could influence their beliefs about who a scientist could be.

## STEM TO STEAM

Research shows that girls start to lose interest in science around middle school, and that interest in a subject is a strong predictor of career choice [4, 5]. So, we created a STEM (science, technology,

engineering, math) lesson for middle school students, called the In Their Eyes: Conservation + Comics program [6]. Teaching STEM in creative ways—such as with comic books—has been shown to be a fun and effective way to learn [7]. To do so, our lesson added art to change STEM to STEAM (science, technology, engineering, ART, math)!

Every part of our lesson featured diverse, real-world scientists as role models: first, there was a classroom lesson in which students read scientific comic books and won scientist trading cards through a vocabulary game (Figure 1). Next, students took a virtual fieldtrip to a national park, for a lesson on biology and conservation taught by a female scientist. After learning about these topics, the students made their own scientific comic books to tell their conservation stories. Lastly, the students took everything they learned and created posters to show to their classes, friends, teachers, families, and 16 diverse guest scientists.

### Figure 1

Two scientist trading cards used as part of our STEAM lesson. (A) The front of Dr. Kristen Lear's trading card tells you her preferred pronouns and what type of scientist she is—a bat conservationist. (B) The front of Earyn McGee's trading card tells you her preferred pronouns and what type of scientist she is—a herpetologist.

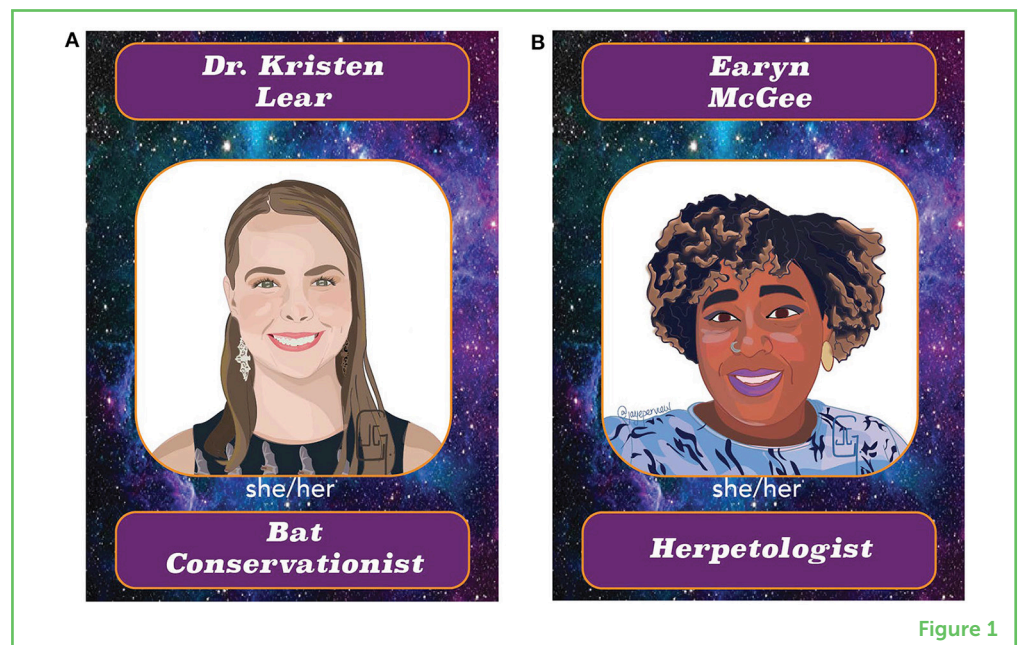


Figure 1

### DID THEY CHANGE THEIR MINDS?

To understand if people's ideas have changed over time, scientists must gather information both before the experiment (like our STEAM lesson) and after the experiment. Then, they compare before (pre-experiment) to after (post-experiment). This tells them if their experiment had any impact on what the person thought, knew, or believed. To test whether our lesson changed the students' ideas about who could be a scientist, we used something called the Draw a Scientist Test (DAST) both before and after the lesson (Figure 2).

The DAST is a method that has been used by scientists and education researchers to study people's **perceptions** of scientists since the

### PERCEPTIONS

Ways of thinking, understanding, or believing something; mental impressions.

## Figure 2

An example of the DAST from our experiment, which uses drawings and questions to learn who a student thinks a scientist can be. Instructions direct the student to draw a scientist and include a caption about what their scientist is saying to them about the work the scientist is doing; students are instructed not to draw themselves, their teacher, or to use the internet. This drawing is of a scientist the student met during the lesson. The drawing caption states, "The scientist is talking to me about all the cool sea life she gets to see at work".

Name: [REDACTED]

### Draw A Scientist, part 2

*Instructions: Imagine that tomorrow you are going on a trip (anywhere) to visit a scientist in a place where the scientist is working right now. In the space below, draw the scientist busy with the work this scientist does. Add a caption, which tells what this scientist might be saying to you about the work you are watching the scientist do. Do not draw yourself or your teacher and do not use the internet or other resources to help you draw your scientist. After you have created your drawing and colored it, upload a photo of your drawing to the box below. You may use plain white paper and the colored pencils (from your supply bag), or a digital drawing tool if you prefer. When you are done, answer the questions on page 2.*

**Caption:** What is this scientist saying to you about the work you are watching the scientist do?

Type here

The scientist is talking to me about all the cool sea life she gets to see at work.

Figure 2

1980s [8]. It has been updated many times over the years and is widely respected. The DAST asks students to "draw a picture of a scientist". The student is also asked follow-up questions, such as: "Was the scientist you drew a man or woman?", "Was the scientist working outdoors or indoors?", and "What was the scientist doing in your picture?".

The drawings and answers from this study were collected and examined to uncover **stereotypical** ideas of scientists. A stereotype is an oversimplified belief about a person that is often wrong, such as "only men can be scientists". Stereotypes like this demonstrate a limited idea of who can be a scientist and what a scientist does. For example, a drawing with facial hair indicates a male scientist, and a person wearing a white lab coat shows only one type of scientist (many scientists do not wear lab coats at all). After analyzing the DASTs,

## STEREOTYPICAL

A widely held, oversimplified idea that is often biased, prejudiced, or wrong.

we then compared the number of stereotypes pre-experiment and post-experiment to see if there was a change.

## MIND DETECTIVES

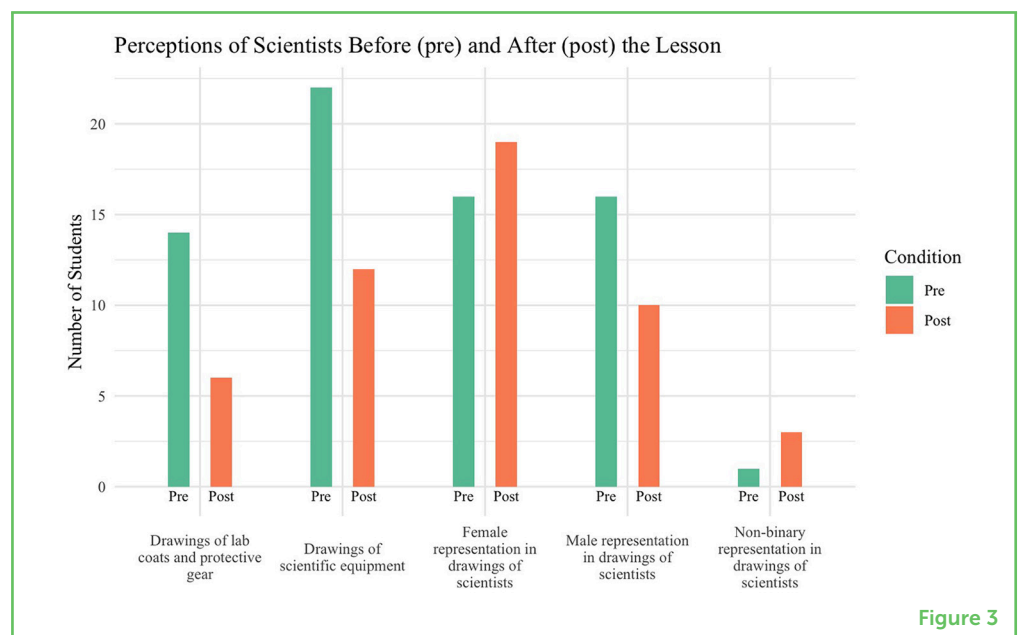
Studying people’s beliefs, thoughts, and knowledge is like being a mind detective! So, did we solve the mystery about how to change people’s perceptions about who can be scientists by using diverse role models?

After reviewing the pre-DASTs and the post-DASTs, we found that students drew fewer stereotypic images in the post-DASTs. Out of the 33 students that completed both pre- and post-DASTS, 22 of them drew traditional scientific equipment (such as beakers and flasks) before the lesson, yet only 12 of them drew this type of equipment after the lesson. In addition, 14 students drew protective gear like lab coats before the lesson, and only 6 students drew protective gear afterward. Lastly, before the lesson, an equal number of students drew men and women as scientists; but after the lesson, 19 students drew women, 10 students drew men, and three students drew non-binary scientists.

We also found that students shifted some of their ideas about science. Our lesson featured diverse women in the field of biology, and the number of drawings that featured biologists increased from 16 to 25. In fact, six students drew scientists they had been introduced to from the lesson (Figure 3)!

**Figure 3**

A bar graph of student perceptions of scientists before and after the lesson. The bars show student DAST responses pre- (green) and post- (orange) lesson. You can see that there were changes in student perceptions—for example, female and non-binary representation increased while male representation decreased.



## PICTURE A SCIENTIST

Why does all of this matter? These numbers show us that our lesson could be breaking harmful stereotypes about what a scientist is and who a scientist can be! By peeking into students' beliefs about science and scientists, we were able to determine one part of a solution to the lack of diversity in STEM fields. It will take a lot of work to make STEM equal for everyone, but this could be one important step toward future success.

Now, picture a scientist again—who do you imagine this time?

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## ORIGINAL SOURCE ARTICLE

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## YOUNG REVIEWERS

### MAE, AGE: 14

My name is Mae. I enjoy art, math, reading, and playing Minecraft. I delight in learning about the world, and finding patterns. I like learning about, and advocating for disability rights.



### TOBY, AGE: 12

I like to play video games and I have two cats.



## AUTHORS

### SAMANTHA WYNNS

Samantha Wynns is a conservation biologist who both does science and communicates science in her job with the National Park Service at Cabrillo National Monument. Diversity, equity, inclusion, and justice are important to Sam and her favorite project is leading a STEM summer camp for underserved girls. In every



role, Sam's goal is to inspire a passion for STEM and a commitment to protecting the environment. She, her husband, two rescue cats, and a very friendly parrot live in beautiful San Diego, California (image courtesy of [IF/THEN® Collection](#)). \*[wynns.conservation@gmail.com](mailto:wynns.conservation@gmail.com)



### **CLARA L. MEADERS**

Award-winning assistant teaching professor Dr. Claire Meaders gets and keeps students of all ages excited about biology. Claire holds a Bachelor of Science degree in cell and molecular biology from Brown University and a Ph.D. in organismic and evolutionary biology from Harvard University. Outside of the lab, Claire loves baking and baking reality TV shows, and she recently ran her 15th marathon! (image courtesy of [IF/THEN® Collection](#)). \*[cmeaders@ucsd.edu](mailto:cmeaders@ucsd.edu)



### **JAYE C. GARDINER**

Nationally recognized biomedical research scientist Dr. Jaye Gardiner uses her knowledge of the microscopic world to understand what occurs in diseases like viral infections or cancer. Jaye combines her talents in STEM and as an artist to show that science is for everyone, by creating scientist trading cards and comics about science and scientists. Jaye enjoys working with youth and guiding them through the scientific process as they conduct their own independent research projects (image courtesy of [IF/THEN® Collection](#)).



### **SANKALP NIGAM**

Sankalp Nigam is a recent graduate from UC San Diego with a human biology degree. He is incredibly passionate about the importance of providing high-quality and inclusive education, especially to younger generations. He believes it is important to constantly improve educational efforts and make learning more personalized to individuals. He hopes to continue his passion for education in the future as a physician so he can contribute to spreading medical knowledge throughout underserved communities, with the overall goal of improving healthcare in these areas.



### **JILLIAN HARRIS**

Hi, I am Jillian Harris. When I was a kid, I dreamed of becoming a doctor or scientist, and I am working hard to make that dream come true! When I am not studying for school, I love watching TV shows and movies, and I enjoy exercising to stay healthy. My favorite TV show is "Bridgerton", and my favorite movie is "The Incredibles". I swam competitively for 12 years, so you can often find me near a pool. Whether I am lifeguarding, teaching swim lessons, or just swimming laps for fun, being in the water is one of my favorite things to do.