# In a "Scientist Spotlight" Intervention, Diverse Student Identities Matter†

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**We report on a brief, simple, online course intervention designed to reduce identity gaps and help students see their "possible selves" in working scientists. Students (*n* = 238) in a large-enrollment, introductory biology course for nonmajors were assigned nine podcasts, distributed throughout the semester. These podcasts each featured a scientist telling a "true, personal story about science," and we intentionally selected podcasts featuring scientists from diverse backgrounds. We hypothesized that this intervention would serve to broaden student perceptions of science and scientists, and we used a mixed-methods approach to analyze (a) survey data and (b) short written responses about how these podcasts impacted students' views of the people who do science. Student survey responses confirm that students overwhelmingly found the podcasts valuable, engaging, and relatable, and student impressions varied as a function of student identity (gender, religiosity, sexual orientation, etc.). Further, these podcasts changed student perceptions of the sort of people who do science. This work builds on earlier findings and expands the current work to include a look at how students from a range of different identities—hidden and visible—respond to a simple intervention designed to counter stereotypes about scientists.**

## INTRODUCTION

The United States is currently struggling to populate its science workforce, which is a serious economic concern. The dearth of qualified science workers is exacerbated by uneven participation in science across sociodemographic groups. Specifically, members of racial and ethnic minority groups, first-generation college students, and women are underrepresented in a variety of science fields (1, 2). Further, attrition rates in science majors, although generally high, appear to be highest for members of groups that have a history of underrepresentation in science fields (3).

Sociodemographic disparities in science fields are not due to group differences in ability (e.g., 4); rather, these disparities appear to be caused by challenges that differentially impact members of underrepresented groups as they pursue science careers (5). For example, relative to their white, male, continuing-generation counterparts, members of underrepresented groups tend to report lower levels of confidence and sense of belonging in science (6). They also encounter negative stereotypes about their ability to succeed in science, which can contribute to anxiety and psychological threat in high-stakes testing situations [i.e., stereotype threat; (7)]. When encountered over time, these negative affective experiences can have an adverse impact on important academic outcomes such as participation, performance, and persistence (8, 9). Social cognitive theory (10, 11) provides a framework for understanding these phenomena: basically, individuals position themselves—and their future selves—through a lifetime of observing and interacting with others in various social contexts. Social cognitive theory, and its derivative—social cognitive career theory (12)—has been applied by many others seeking to understand retention in STEM (13–17).

Specifically, differences in students' sense of belonging in science are inextricably linked to how students perceive who does science, and whether these students identify with scientist prototypes (18, 19). For example, multiple studies have illustrated that in the United States, the dominant scientist stereotype is that of an older white male (20). These images begin early and persist through high school and college (21–23). Further, there is evidence that these perceptions contribute to a sense of not belonging in STEM, as expressed by individuals who do not identify with this scientist stereotype (24, 25). These findings are underscored by additional work on the positive value of role models of the same gender, race, or ethnicity, for example (26–30). Consequently, some belongingness interventions involve the use of counterstereotypical role models (31–34).

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For example, Schinske *et al.* (34) describe the development, implementation, and assessment of a series of "Scientist Spotlight" assignments in a human biology course. Specifically, students engaged with the work of a diverse array of scientists, many with counter-stereotypical expressed identities (e.g., nonwhite, female) in an effort to permit a diverse population of students to detect their "possible selves" in one or more of these scientists. Students in the Scientist Spotlight course sections shifted their descriptions of scientists to include more counterstereotypical features and expressed an ability to relate more to scientists; further, relatability appeared to correlate positively with interest in science and course grades.

At our institution, recent findings (35) have conveyed the extent to which *hidden identities*, such as religiosity, politics, sexual orientation, and commuter status significantly impact student perceptions of belonging in the classroom—especially in courses that emphasize interactive pedagogies. For example, at our politically liberal institution (36, 37), politically conservative students are less willing to express themselves in class discussions, and feel that they will be judged—by their peers and their instructors—for their political identities. In our biology courses, which emphasize evolution and the age of the earth, some religious students express a reluctance to contribute in peer-group discussions. And lesbian, gay, bisexual, and transgender students have shared their concerns about "outing" themselves in these same discussions. These findings complement prior work illustrating that our underrepresented students (i.e., women and racial and ethnic minorities) express less identity as a scientist than do the white men in our introductory biology courses (38), as well as the work of others illustrating how religious students may feel they do not belong in biology (39). Thus, we are concerned about sense of belonging and science identity in students considered *traditionally* underrepresented in STEM (e.g., women, certain racial and ethnic groups) as well as those with hidden identities (e.g., religion, politics, sexual orientation) that have led to feelings of marginalization.

Here we report on a brief, simple, online course intervention modeled after Schinske's "Scientist Spotlight" assignment (34), designed to reduce the identity gaps previously disclosed and help students see their "possible selves" in working scientists. Students (*n* = 238) in a large-enrollment, introductory biology course for nonmajors were assigned nine podcasts, distributed throughout the fall 2018 semester. These podcasts each featured a scientist telling a "true, personal story about science," and we intentionally selected podcasts featuring scientists from diverse backgrounds. We began with the following research questions (RQs):

RQ1: Do students find these podcasts valuable and engaging?

RQ2: Do these podcasts change student perceptions of what sort of people do science?

RQ3: How do students relate to the scientists, if at all?

RQ4: Do student impressions vary as a function of student identity (gender, religiosity, sexual orientation, etc.)?

We hypothesized that this intervention would serve to broaden student perceptions of science and scientists; further, we predicted that this effect would be largest among students typically underrepresented in STEM. This work builds on earlier findings and expands the current work to include a look at how students from a range of different identities—hidden and visible—respond to the different podcasts.

## METHODS

### Student population

Our population (*n* = 238) included only students enrolled in one of two, 119-person sections of a nonmajors introductory biology course. This course, The Evolution and Biology of Sex, involves a diverse group of students in a discussion of biology, from molecules to ecosystems, albeit from the lens of sex (sexual reproduction, the evolution of sex, mating systems, sexual orientation, sex and gender, etc.). With its combined emphases on both evolution (especially human evolution) and sex, the course involves discussion of many potentially polarizing topics. Prior work has emphasized the diverse nature of the student population (25), the active-learning pedagogies employed (40), and various aspects of the laboratory curriculum (41–44). The population discussed here was 62% female, 26% non-white, 12% underrepresented minority (URM; in this case, African American, Hispanic, Native American, Pacific Islander), and 17% first-generation college.

### "Scientist Spotlight" assignment

As a relatively small part of the course grade (8 points maximum, out of a total 270 points), students were assigned, via a course-management online system, a series of 9 "Scientist Spotlight" podcasts, followed by short quizzes. Students could either skip one of the podcasts or drop their lowest Scientist Spotlight quiz.

Podcasts were selected from the Story Collider podcast library at www.storycollider.org. Each podcast was chosen based on three features: the identity or identities of the scientist (gender, race, ethnicity, sexuality, religious upbringing or practice, etc.); the scientist's area of interest, designed to, at a minimum, loosely align with course topics; and the appeal of the story itself. For example, one podcast featured Jennifer Colbourne, a female graduate student studying ecology and evolution; Colbourne was raised in an evangelical Pentecostal home and worried about the impact of her research on her relationship with her family members. Students listened to—or read a transcript of—this podcast after a discussion of the mechanisms of evolution. Another podcast, assigned during initial discussions of the social nature of science, featured Dr. Rayshawn Ray, a sociologist sharing his story of how his own work was affected

by the killing of Philando Castile by a police officer. Castile's killing occurred very close to our campus and drew national attention. Table 1 outlines the selected podcasts, and the rationale for their selection.

After listening to, or reading, each podcast, students completed a three-item quiz. The first two items were always multiple-choice questions, and fairly straightforward; the aim was for these to be easy to answer correctly, provided the student had paid attention to the story. If students answered both items correctly, they earned one point for the quiz. The third question was open-ended and ungraded, and included two options. One option varied and was topic-specific, and one option was always "How did listening to this podcast impact your perceptions of the kind of people that do science?"

### Pre- and post-semester surveys

Prior to the start of class, students completed a pre-course survey that was designed to meet the needs of several ongoing research projects in the department. For the purposes of the work described herein, the survey asked about science confidence and science identity. Science confidence was measured by averaging responses to an eleven-item construct that asked students about their confidence in their ability to do various tasks related to science, such as "Design a well-controlled experiment to test a hypothesis," or "Explain an experiment, the results, and analysis in writing." These items were developed in-house, loosely based on other work (45, 46), and have been used in several other studies with a similar population (26, 43, 47); further, individual items have undergone think-aloud validation with a subset of a similar group of students (previously

enrolled in this course). For science identity, students were specifically asked to rate how much the phrase "a science person" described themselves—from "not at all like me" to "very much like me" (48).

At the conclusion of the semester, students completed a longer survey, including items from the pre-course survey in addition to some specific to the Scientist Spotlight assignment. In addition to asking students to evaluate each story in terms of engagement and relatability, we also asked about the value of the assignments overall ("Did you find this aspect of the course ["science culture"] valuable?") and whether the assignments impacted their views of science and scientists. As part of a larger study (35), we collected information on various aspects of student identity, including gender, race or ethnicity, and several "hidden" aspects of identity (e.g., generation in college, sexual orientation, politics, and religiosity). The relevant survey items are included as Supplemental file 1. The survey and study protocol were exempt from full consideration by our institution's IRB office.

### Data analysis

We used a mixed-methods design to address our hypothesis. For our qualitative analysis, we analyzed written responses to the optional (of two choices) quiz question, "How did listening to this podcast impact your perceptions of the kind of people that do science?" Specifically, we randomly selected (using a random-number generator) 100 written responses to each podcast assignment, for a total of 900 responses analyzed. Using two-cycle *in vivo* coding, two researchers (AY and MS) worked independently to assign student response codes to consensus categories (Table 2). As our source material consisted of brief samples of

TABLE 1.
Scientists featured in the Scientist Spotlight assignments.

| Scientist(s) | Shared or Expressed Identities | Course-Related Content or Skills |
|---|---|---|
| Rayshawn Ray | Male, African American, Sociologist | Science communication, implicit bias |
| Marcelo Sayao | Male, Hispanic, Catholic, Ecologist | Cervical cancer |
| Jennifer Colbourne | Female, White, Pentecostal Background, Evolutionary Biologist | Evolution |
| Bill Harwood | Male, White, Chemist and Police Officer | Biochemistry in forensics |
| Rabiah Mayas | Female, African American, Molecular Biologist | DNA, twinning |
| Neer Asherie and Deborah Berebichez | Male and Female, White and Hispanic, Physicists | Biology of love and attraction |
| Joe Normandin | Male, White, Gay, Neuroscientist | Biology of sexuality |
| Veronica Ades | Female, White, Obstetrician | Maternal mortality, biology of childbirth |
| Wendy Suzuki | Female, Asian, Neuroscientist | Biology of love and attraction |

TABLE 2.
Emergent themes identified in students' free responses to the Scientist Spotlights.

| Code | Definition | Example |
|---|---|---|
| Traditional stereotypes | Responses in this category are those that mention stereotypes about scientists. In the majority of cases, they are stating that the scientists in the podcasts challenge these stereotypes. | • "It is easy to assume that the type of people involved in science study detached and highly intellectual aspects of life that don't necessarily affect the daily lives of 'normal' people."<br>• "I picture a scientist as an old white guy in a lab coat either hunched over a beaker or lecturing about things I can never understand." |
| Changed perspectives | Responses in this category mention how these podcasts have changed their views on scientists. | • "This made me realize scientists are more like me than I thought."<br>• "This story helped to reshape thoughts about scientists that I was already predisposed to." |
| Passion | Responses in this category mention the passion or drive one must have in order to be a scientist. | • "People who do science love science with a passion and aren't just doing it because they have to."<br>• "In all of these culture quiz stories that I have been listening to, every single person has had that same passion, but shown in different ways." |
| Scientists are diverse | Responses in this category note that there is not a single archetype for a scientist. | • "This shows you that no matter your background, many different types of people partake in science."<br>• "People who do science come from all walks of life. You don't just need to be a Caucasian heterosexual man to be a scientist." |
| Science is diverse | Responses in this category note that science is very broad and contains many sub-fields. | • "They work in all sorts of fields and are not always found in lab coats mixing chemicals in beakers."<br>• "I always assumed science was very narrow, when in fact it is so broad." |
| Science communication | Responses in this category mention the benefits of science being available beyond labs and classrooms. | • "[Ray] knows that what he is doing cannot live in a library, it needs to be able to be shared and consulted easily."<br>• "Even I, someone who isn't science inclined in the least, can learn from science and use the things I learn in my everyday life." |
| Scientists are people too | Responses in this category mention that scientists are just as human as anybody else. | • "This tells me that scientists are emotional. They are emotional like everyone else."<br>• "Scientists are multi-dimensional people who are not defined entirely by stereotypes. Rather, their involvement in science is one (albeit important) aspect that contributes to their overall life." |
| Benefit the world | Responses in this category mention how scientists' inspiration can come from a desire to better the world around them. | • "The type of people who do science are those who want to make a change in the world. With the research they do, they try to find solutions to existing problems."<br>• "The type of people who do science can be inspired by what they do to help others and make a difference in the community." |

verbatim text, our methodology best fit Ryan and Bernard's "cutting and sorting" technique (49), whereby researchers initially read all responses, then looked for similarities, differences, and repetition among phrases (see also [50]). Specifically, they were tasked with identifying a suite of themes to highlight how students perceive scientists and how those perceptions may change as a result of listening to the podcasts. Between the first and second cycles, the two researchers met once to develop final themes, and again for consensus coding for the first two assignments. Assignments three through nine did not undergo consensus coding. However, percent agreement—the number of agreed-upon themes for codes divided by the total number of codes—on each of these assignments exceeded 88%. Only consensus assignments are reported here.

Similar coding was used to categorize how students related to the scientists, in response to the open-ended post-course survey prompt, "Please explain your answer to the question above," following a constrained-choice question about the relatability of individual scientists. For these samples, all student responses were analyzed but not subjected to consensus coding. As with the perceptions prompt (discussed above), level of agreement on how codes were assigned to themes was high, exceeding 85% for all assignments. Following two-cycle coding, a third researcher aligned categorized comments with student characteristics (e.g., gender, URM status, religiosity, politics, sexual orientation). Consensus categories are described in Table 3.

For our quantitative analyses, we used one-way ANOVAs to test whether impressions of the podcasts varied as a

TABLE 3.
Emergent themes identified in the "relatability" prompt on the post-course survey.

| Code | Definition | Example |
|------|-----------|---------|
| Personal experience (identical) | Responses in this category note strong similarities between the student's experiences and those of a scientist | • "Rabiah Mayas was most interesting to me because she talked about twins and I am also a twin so I related very well." (male, white, 21) |
| Personal experience (similar) | Responses in this category are those that mention any similarity between the experiences of the student and of a scientist | • "I connected with the homosexuality one the most because I have a lot of homosexual friends" (female, white, 19) |
| Similar identity (religion) | Responses in this category note a connection with a scientist based on a shared religion | • "Jennifer's story was relatable because I have struggled with finding a connecting point between religion and science." (slightly religious, female, white, 22) |
| Similar identity (LGBQ) | Responses in this category are those that note a shared LGBQ identity with a scientist, and a feeling of connection resulting from this | • "The sexuality podcast on nature vs. nurture was also very helpful as understanding the origins of Homosexuality and learning a new way to look at my own sexuality." (bisexual, female, white, 22) |
| Similar identity (race/ ethnicity/culture) | Responses in this category are those that mention a connection with a scientist due to their race, ethnicity, or culture | • "Rayshawn Ray just due to this type of stuff happening most to people of color." (female, Black, 22) |
| Professional, avocational interests | Responses in this category mention interests in a scientist's field, and/or a connection resulting from this | • "The first one about police bias was most engaging to me because of my prior experience pursuing a criminal justice degree." (male, Asian, 28) |
| Normal human emotions | Responses in this category mention a feeling of connection based on a scientist's description of emotions | • "I liked the podcasts that talked about the individual's emotional journeys and how science helped them because that is what made it seem most relatable." (male, white, 19) |

function of student identities, and to test whether student confidence or science identity changed over the course of the semester. To facilitate analysis and interpretation, some categories were collapsed. For example, "conservative" and "very conservative" students were collapsed into the category "conservative;" similarly, "liberal" and "very liberal" were collapsed into the category "liberal." Further, transgender students were assigned to their accustomed gender as male or female for quantitative analysis.

## RESULTS

### RQ1: Do students find these podcasts valuable and engaging?

Between 180 (76%) and 222 (93%) of the students completed each of the Scientist Spotlight assignments, and scores averaged between 0.87 and 0.94 (out of 1-point total) on the quizzes. Between 194 and 205 students (~80% to 85% of the total in the course) completed each of the post-course survey items about the podcasts. In response to the question "Did you find this aspect of the course valuable?,"

90% of respondents found the Scientist Spotlight podcasts either somewhat, very, or among the most valuable activities of the semester (Fig. 1). However, 10% reported the podcasts to be "not at all valuable."

We also asked students to rate their engagement with the individual podcasts. While average responses varied, each scientist was found to be "among the most engaging" by at least some of the students (Fig. 2).

### RQ2: Do these podcasts change student perceptions of what sort of people do science?

In response to the question, "Did listening to these podcasts change how you view scientists?," over 90% responded either minimally, somewhat, significantly, or extremely (Fig. 3). And when asked, "Did listening to these podcasts change how you view science in general?," these numbers were similar, with fewer than 10% of students selecting "not at all."

Students' open-ended responses on quizzes and the post-course survey provide additional insight into their impressions of the podcasts. For example, students had a lot to say in response to the ungraded quiz question "How did listening to this podcast impact your perceptions of the kind
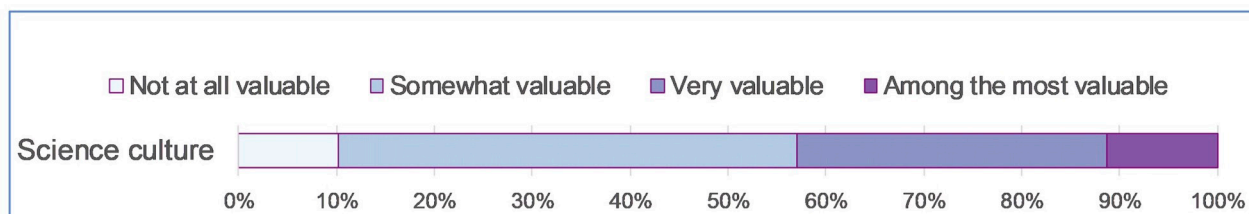
FIGURE 1. Student assessment of the value of the Scientist Spotlight assignments. Responses are broken down by Likert-scale selections to the question "Did you find this aspect of the course valuable?"

of people that do science?" Specifically, students responded in the following categories from Table 2:

- Traditional stereotypes (117 out of 900 total comments, or 13%). Many students took this opportunity to share their own stereotypes about scientists, sharing that "This opened my eyes to the diversity within the scientific community. I feel like as a whole in our society, people assume scientists to be white male middle to upper class people; however that is obviously not the case," and "I picture a scientist as an old white guy in a lab coat either hunched over a beaker or lecturing about things I can never understand." In fact, the "old white guy" stereotype came up several times. For example, in response to the Rayshawn Ray podcast, one student wrote, "I think this showed that 'science' is not always taking place in a lab with old white men in coats," and another said, "Scientists aren't just stuffy old men wearing white lab coats and top hats puffing cigars, but are active members of the global community."
- Changed perspectives (163; 18%). Each podcast elicited some responses in this category, such as, "It makes me want to second guess stereotypes about people in sciences," and "This story changed the way that I viewed science, and its practical applications in the real world."

- Passion (157; 17%). Many students used the word *passion*, in addition to similar terms, to describe the internal motivations of scientists. One person wrote, "In all of these [podcasts] that I have been listening to, every single person has had that same passion, but shown in different ways." Another explained, "I believe the type of people that do science or conduct research have to have a certain connection/drive that propels them to reach a better understanding or explore a new finding."
- Scientists are diverse (155; 17%). Some of the responses in this category spoke to diversity in general, with comments such as, "This shows you that no matter your background, many different types of people partake in science." But others tackled specific stereotypes: "People who do science come from all walks of life. You don't just need to be a Caucasian heterosexual man to be a scientist." Another concluded "There is no cookie cutter scientist!"
- Science is diverse (95; 11%). Many students rejected classical perceptions of science, such as, "the people who are interested in science are not just the people who are interested in watching bacteria grow in a lab," and "Science doesn't have to just be fossils or studying plants it can tie in with your identity too." Many of these
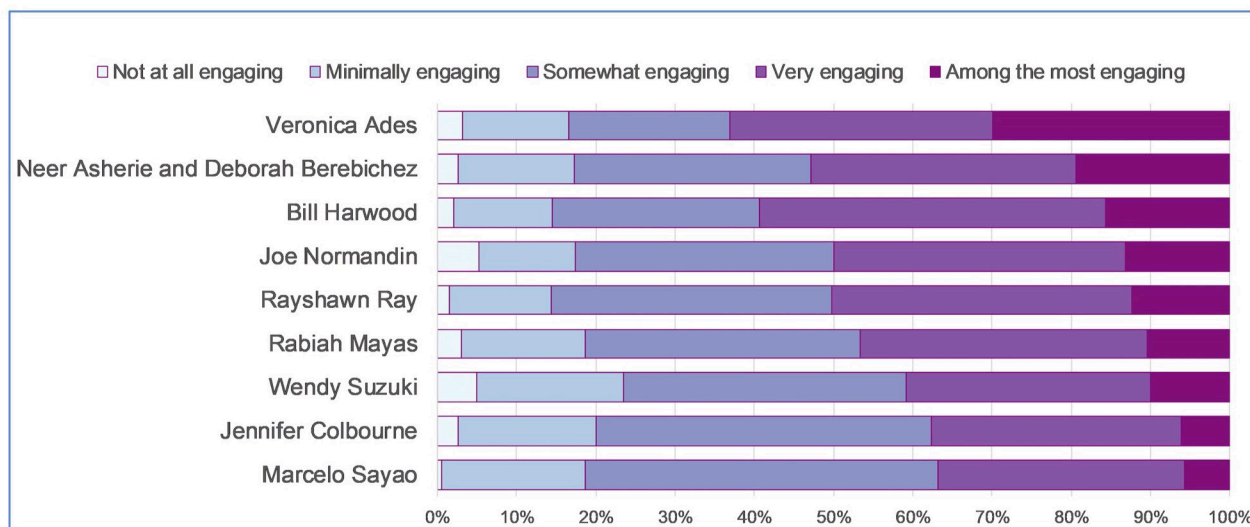


FIGURE 2. Student assessment of their level of engagement with each of the Scientist Spotlights. Responses are broken down by Likert-scale selections to the prompt "Please comment on the level to which you were engaged by each podcast."
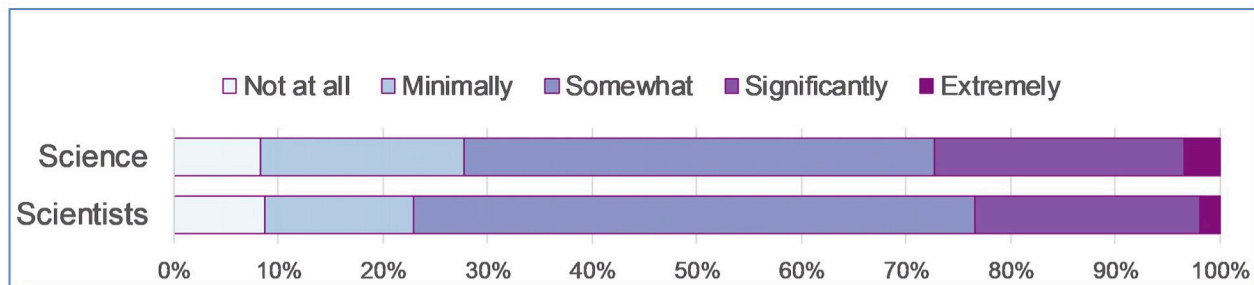
FIGURE 3. Student assessment of how their perceptions changed in response to the Scientist Spotlight assignments. Responses are broken down by Likert-scale selections to two distinct prompts: "Did listening to these podcasts change how you view *scientists*?" and "Did listening to these podcasts change how you view *science* in general?"

statements invoked lab coats, beakers, and chemicals, perhaps best exemplified by this comment: "They work in all sorts of fields and are not always found in lab coats mixing chemicals in beakers."

- Science communication (79; 9%). Students found several different ways of talking about the importance of sharing science with the world, with comments such as, "This podcast also shows how science is intertwined into different work fields, like police work, that we don't think of on a daily basis," and "Even I, someone who isn't science inclined in the least, can learn from science and use the things I learn in my everyday life."
- Scientists are people too (136; 15%). Students often mentioned humanity and the expression of emotions in this category. One wrote, "This story shows that in science, scientists sometimes fail or disappoint themselves. Even though hard work is put into their work, failure is allowed and is a sign that one is human." And another said, "Science people are emotional. Not that that is bad, but it makes them seem more human."

- Benefits the world (65; 7%). These comments went beyond those categorized under "Science communication," specifically by mentioning the potential benefits of scientific knowledge. For example, one student wrote, "This story shows that many people choose to 'do science' in order to help those around them." And another said, "The type of people who do science are those who want to make a change in the world. With the research they do, they try to find solutions to existing problems."

**RQ3: How do students relate to the scientists, if at all?**

When asked to rate the relatability of each of the featured scientists, each person was identified as "among the most relatable" by some of the students (Fig. 4).

Again, the students' free responses are illustrative. When asked to elaborate on their relatability ratings, student comments aligned with the following categories (from Table 3):
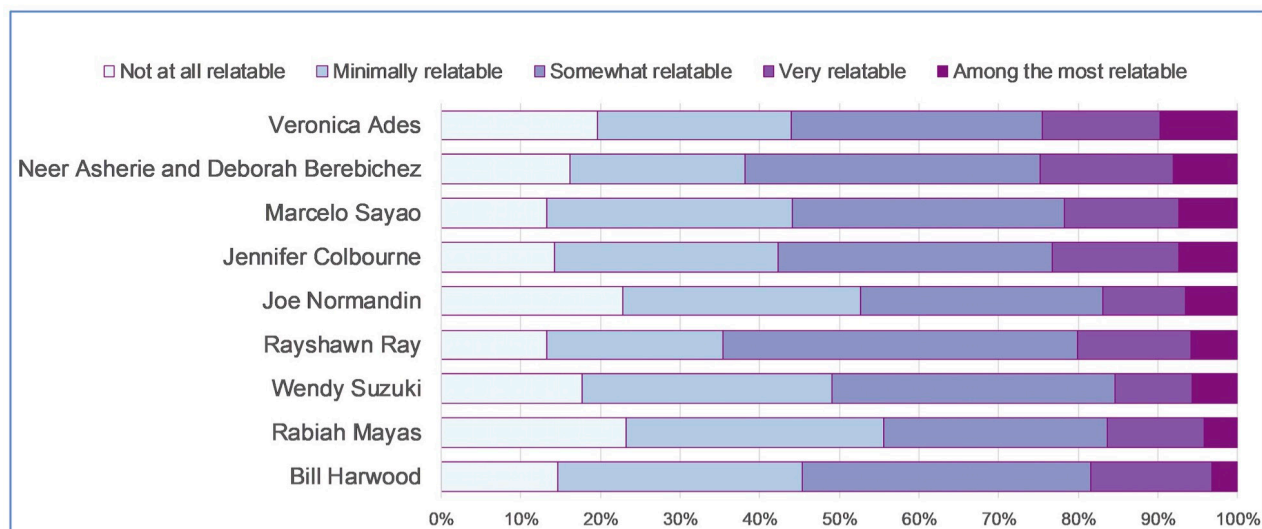


FIGURE 4. Student assessment of the relatability of each of the Scientist Spotlights. Responses are broken down by Likert-scale selections to the prompts "For whatever reason or reasons, which of the following podcasts did you connect with, or relate to, the most?"

- Personal experience, similar. Many students invoked their own similar experiences or personal connections to the scientist's story, such as, "Being from the Twin Cities, it was easy to relate to Rayshawn Ray's story about how he responded to Philando Castile's death and his desire to do something" (female, white), or "I connected with the homosexuality one the most because I have a lot of homosexual friends" (female, white).
- Personal experience, identical. Some respondents reported an identical experience, for example, "The one involving cancer, and cervical cancer, I found interesting and related to because my mom had cervical cancer. She is cancer free now but it was interesting and informative to learn about" (female, white). Others claimed identical identities to the scientist(s): "Rabiah Mayas was most interesting to me because she talked about twins and I am also a twin so I related very well" (male, white).
- Religious identity. The scientists who discussed the interface of their science and their faith were relatable for many students. One stated, "For me, the one that talked about how religion and science were able to work together was very relatable because it is something that I have thought through a lot" (very religious, female, white). And another shared, "The one where someone died from cancer was very relatable. My mother has stage 4 breast cancer and that podcast really connected with me and losing my faith with God" (slightly religious, female, white).
- Sexual-orientation identity. One scientist specifically discussed his own homosexuality, and his questions about the science of sexual orientation. Many students related both to the scientist ("Because I'm gay I found that one the most relatable"—gay, male, Hispanic), as well as the story ("I appreciated the nuance of the biology of homosexuality—as a queer individual I think a lot about where queer theory and biology intersect and who should be doing that science"—queer, female, white).
- Race/culture/ethnic identity. In this category, students often invoked race—either of the scientists or the subject of their stories. For example, Dr. Ades discusses her intimate encounters with maternal mortality in South Sudan, and one student noted, "This story [Veronica Ades] really engaged me because it's something that a lot of women of color have to go through" (female, black). Another said, of Dr. Ray's story about Philando Castile,

"Rayshawn Ray just due to this type of stuff happening most to people of color" (female, black).
- Professional or avocational interests. Several comments centered on shared career interests or hobbies, such as, "The most relatable one again was the police officer, because he had a similar background as I did. I am now headed out to do police work full time so it was interesting to see how science relates to my field" (male, Asian), and "The podcast with Veronica Ades was interesting to me because I've always been fascinated with obstetrics" (female, American Indian).
- Normal human emotions. Many students found a connection with the scientists simply because of shared human emotions. One student said, "I loved the one about the physicists in love because not everyone can be a scientist but a lot of people can fall in love. It was most relatable to me because I have experienced love and I could relate to their feelings" (female, Hispanic). And another commented, "The ones that had the most personal and revealing stories felt more relatable because they shared struggles that they had gone through and decisions and things they had to overcome" (female, white).

**RQ4: Do student impressions vary as a function of student identity (gender, religiosity, sexual orientation, etc.)?**

In addition to the institutional data reported above—62% female, 26% non-white, 12% URM, and 17% first-generation college—students self-identified as 12% LGBQ (Lesbian, Gay, Bisexual, or Queer; it is our institutional standard to assign T (transgender) students, to their accustomed gender as male or female), 15% non-political, 21% conservative, 18% middle-of-the-road politically, and 46% liberal. Additionally, 35% identified as not religious, 32% as slightly religious, and 33% as moderately or very religious. No students self-identified as non-binary or transgender.

Pre-course science identities and average science confidence scores (Table 4) were similar to those reported previously (26, 43, 47), whereby females typically enter introductory-biology courses exhibiting lower science confidence (2.67 on a 5-point scale), and claiming a lower sense of science identity (2.15 on a 5-point scale) than their male counterparts (2.85 and 2.66, respectively). We did not see

TABLE 4.
Average student science confidence and science identity, pre- and post-course.

|  | Total | Average M:F | Average Non-URM:URM | Average CGEN:FGEN |
|---|---|---|---|---|
| Pre: Average Science Confidence | 2.74 | 2.85:2.67* | 2.74:2.73 | 2.75:2.67 |
| Post: Average Science Confidence | 3.14 | 3.15:3.13 | 3.14:3.17 | 3.14:3.12 |
| Pre: Average Science Identity | 2.33 | 2.66:2.15*** | 2.31:2.44 | 2.3:2.47 |
| Post: Average Science Identity | 2.53 | 2.79:2.39* | 2.56:2.29 | 2.56:2.33 |

Differences are significant at *$p<0.05$; ***$p<0.001$.

URM = underrepresented minority; CGEN = continuing-generation college; FGEN = first-generation college.

differences between non-URM and URM students or between continuing-generation and first-generation college students; however, smaller sample sizes may have led our results to be less representative of the population as a whole. For women, science identity and science confidence increased over the course of the semester; in fact, the increase in science confidence appeared to close the gap between men and women; the same cannot be said for science identity.

Not all students responded similarly to each of the scientists. Women, LGBQ students, and politically liberal students expressed greater *engagement* with many of the podcasts (Fig. 5). Rayshawn Ray, the sociologist describing his response to the killing of Philando Castile, elicited strong engagement from women and politically liberal students, as did Joe Normandin and Veronica Ades.

Further distinctions emerged when evaluating how students *related* to the scientists. With eight of the nine podcasts, student politics were a factor—for seven of them, liberal students found the scientists more relatable. Only Bill Harwood, the chemist and police officer, was seen as more relatable by conservative, rather than liberal or apolitical, students (Fig. 6). Joe Normandin, the neuroscientist who discusses his own homosexuality as well as the science of sexual orientation, was found to be more relatable to women, LGBQ students, and politically liberal students—but less relatable to moderately or very religious students. Conversely, religious students found both Marcelo Sayao and Jennifer Colbourne (both of whom spoke about reconciliation between faith and science) more relatable than did their less-religious peers. Also, URM students found

| | Gender | URM | LGBQ | Religiosity | Politics |
|---|---|---|---|---|---|
| Rayshawn Ray | *** | | | | *** |
| Marcelo Sayao | ** | | | | * |
| Jennifer Colbourne | * | | * | | |
| Bill Harwood | | | | | |
| Rabiah Mayas | ** | | | | |
| N Asherie and D Berebichez | ** | | | | |
| Joe Normandin | * | | | | * |
| Veronica Ades | *** | | | | * |
| Wendy Suzuki | | | | | |

FIGURE 5. Differences in self-reported student engagement with each of the nine scientists featured. For each category, the following coding scheme was implemented: gender (0=male; 1=female); URM (0=no; 1=yes); lesbian, gay, bisexual, queer (LGBQ; 0=no; 1=yes); religiosity (none, slightly, moderately, very); politics (0=conservative; 1=liberal). Colors and asterisks denote directional significance: *$p<0.05$; **$p<0.01$; ***$p<0.001$ with yellow/orange/red denoting higher values in women, LGBQ, and politically liberal students.

| | Gender | URM | LGBQ | Religiosity | Politics |
|---|---|---|---|---|---|
| Rayshawn Ray | | | | | ** |
| Marcelo Sayao | | ** | | ** | ** |
| Jennifer Colbourne | | * | | *** | * |
| Bill Harwood | | | | | * |
| Rabiah Mayas | | | | | |
| N Asherie and D Berebichez | ** | | | | * |
| Joe Normandin | ** | | *** | ** | ** |
| Veronica Ades | ** | | * | | *** |
| Wendy Suzuki | | | * | | *** |

FIGURE 6. Differences in self-reported student relatability to each of the nine scientists featured. For each category, the following coding scheme was implemented: gender (0=male; 1=female); URM (0=no; 1=yes); LGBQ (0=no; 1=yes); religiosity (none, slightly, moderately, very); politics (0=conservative; 1=liberal). Colors and asterisks denote directional significance: *$p<0.05$; **$p<0.01$; ***$p<0.001$ with yellow/orange/red denoting higher values in women, URM, LGBQ, more religious, and politically liberal students and aqua/blue denoting higher values in men, non-URM, non-LGBQ, less religious, and politically conservative students.

both Colbourne and Sayao significantly less relatable than did their non-URM counterparts.

## DISCUSSION

Given the nature of this course—appealing to the most science-averse students at our institution—we are encouraged by the fact that 90% of the students found the podcasts somewhat, very, or among the most valuable (Fig. 2). The engagement findings are even more compelling, with only a few students for each podcast finding them "not at all engaging." Further, the distinctions between the individual podcasts were not large.

Based on several lines of evidence—free responses on individual quizzes and post-course surveys—the Scientist Spotlight assignments change student perceptions of the type of people who do science. The number of student comments that were grouped in the "changed perspective" category ranged from seven, for Rabiah Mayas, to 30, for both Rayshawn Ray and Jennifer Colbourne. Many students specifically called out the "old white guy" stereotype, and many rejected the notion that scientists are emotionless nerds. Further, many students—from across the spectrum of religiosity—appreciated the two scientists who spoke about reconciling their faith with their science, suggesting an underlying stereotype about scientists all being atheists, or at least non-religious.

Students are clearly invoking their own identities in ascribing relatability to podcasts, with direct comments such as, "Because I'm gay I found that one the most relatable" (gay, male, Hispanic), and "I think being from Kenya listening to the horror stories about women giving birth and being able to survive but also looking at infant mortality, hits so close to home. [Since I come] from a large family of doctors, issues like this are very important and play a very large role" (female, Black).

We are encouraged by the fact that, although many of our religious students adhere to Islam, they still related to those scientists discussing the relationship between their science and their faith—even though both scientists came from Christian backgrounds. One self-identified Muslim female student shared:

> I perceive the relationship between science and religion as one that can help the other out, essentially being 'complementary,' as Dr. Sayao […] stated. I think that when religion cannot help explain to people certain phenomen[a] or things that arise in our daily lives, science can, and vice-versa. I also think that the relationship between the two is really cool in the sense that it works in two ways; one being that science provides people with comfort and concrete evidence as to why something has happened (in Dr. Sayao's case), and religion, as something that is not necessarily concrete (because

it relies on faith), but something that provides people comfort in something greater than us.

## CONCLUSION

Our work has limitations, primarily in the design of the curricular intervention. Specifically, we were unable to establish a [quasi] control for this work for a variety of reasons—the course management software makes separating assignments by section difficult (but not impossible), and historical controls are difficult in a course that is continuously evolving. However, our aim was not one of replication *per se* (e.g., of [26]), and our research questions focused on identifying whether a diverse array of students could see their possible selves in a relatively low-stakes, online assignment designed to loosely complement course material. In that framework, we can make several conclusions and recommendations for further work.

We find that this simple Scientist Spotlight assignment was well received by our students—most individuals completed all assignments, performed well on the post-podcast quizzes, and found the scientists engaging and relatable. Further, we see compelling evidence that the scientists, and their stories, served to counter several stereotypes students held about science and scientists. Also, the entire series of assignments contributed a maximum point value of eight (out of 270 total points in the course), yet students completed the assignments and reflected positively on them. The low-stakes nature of these assignments should be encouraging to other instructors who aim to make their courses more inclusive. Critically, they don't take much time or detract from other content and skills priorities. We are happy to provide any materials in support of others seeking to implement similar assignments.

We were disappointed that many of the podcasts were less relatable to politically conservative students than to their liberal peers. At our institution, conservatives are not only outnumbered, they can feel marginalized in class and less inclined to share their thoughts in group discussions (35). Therefore, future iterations of the Scientist Spotlights will aim to include more overtly conservative voices. This will likely require expanding our reach beyond Story Collider, as this venue does not currently feature *self-professed* conservative scientists. We can follow the example of Schinske *et al.* (26) in looking beyond a single distributor for our podcasts.

To better address our specific population, we can also seek overtly Muslim voices to speak about the reconciliation of science and faith. The fact that our featured religious scientists were both Christian did not seem to impact our Muslim students negatively, but as we did not ask about specific religions in our religiosity prompt (although several students volunteered this information), we don't really know whether the specific faith of the scientists mattered to the students. Further, given the mental-health crisis that our institution—in company with many of our peer institu-

tions—is currently facing, we also aim to identify a scientist whose story includes mental-health challenges.

We caution readers against seeing all students categorized as "marginalized" as equivalent. For example, a trans-woman of color is likely to experience far more overt challenges (including that of personal safety) than is, for example, a white cis-male who is religious and politically conservative. However, given our increasingly polarized world (and increasingly polarized science classrooms), we aimed to approach these spotlights from multiple axes of diversity in order to be inclusive of more student identities than simply gender and race. We realize that attempting to reach every aspect of student identities with these podcasts would be an impossible task, and we will have to reconcile attempts at inclusivity with practicality and other demands of this course. But we conclude that in diversity interventions such as this one, hidden identities—such as politics, religiosity, and sexuality—matter, and simple assignments can counter multiple potentially damaging stereotypes about scientists.

## SUPPLEMENTAL MATERIALS

Appendix 1: Relevant pre- and post-course survey items

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