

Probationary Faculty Development Grant Spring 2021 Report

Curricular Redesign of *Bio2*: Impact of Introducing CSUS Students to Three Non-stereotypical Scientists via “Scientist Spotlights” Discussion Modules

Faculty Information

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Project Objectives

- To foster increased science identity in all *Bio2* students, particularly individuals from underrepresented demographic backgrounds, by scaffolding opportunities for students to view scientists as relatable, resilient individuals.
- To highlight achievements and origin-stories of scientists from non-stereotypical backgrounds, including underrepresented minority individuals or PEERs (Persons historically Excluded from science due to Ethnicity or Race).
- To measure the impact of three custom-made “Scientist Spotlights” discussion modules on students’ perceptions of what it means to be scientist, and to draw inferences about students’ sense of belonging in science.

Project Description

The over-arching goal of this “Scientist Spotlights” education research study is to promote inclusion of persons from diverse backgrounds and broaden participation in STEM fields (science, technology, engineering, and mathematics.) The originators of the Scientist Spotlights pedagogical method, Schinske and colleagues (Schinske, Perkins, Snyder, & Wyer, 2016), postulated that encountering scientists as relatable human beings would facilitate students’ ability to envision new “possible selves” (James 2005) in their futures. Specifically, seeing the success of someone whose interests and personal characteristics resemble their own would promote students’ ability to imagine a “possible science self” (Steinke et al., 2009) : a future version of themselves who has achieved a sense of belonging in STEM and made significant contributions to their chosen professional field. Showing students that becoming a scientist does not require abandoning their current identities helps them imagine new possible futures for themselves.

To foster my students’ formation of science identity and resiliency to persist beyond introductory-level biology courses towards obtaining STEM degrees and careers, I designed and implemented three new “Scientist Spotlights” discussion modules for students in the Spring 2021 offering of *Bio2: Cells, Molecules, and Genes*, which is the second of two introductory biology courses at CSUS. Each module included at least two biographical resources and two scientific research and career development resources about the featured scientist, in a mixture of text and video / animation formats. For each Scientist Spotlights module, students responded to the accompanying questions as written reflection of at least 400 words for peer discussion in Canvas:

1. *What was most interesting to you in reviewing these resources?*
2. *What did you learn about [specific topic relevant to the featured scientist’s research and *Bio2* course topics] from these resources?*

3. *What new questions do you have after reviewing these resources?*
4. *What do these resources tell you about the types of people that do science?*
5. *[A variable question designed to foster peer-discussion in Canvas.] For example, asking students to reflect on past, present, or future people they know who have helped (or could help) them pursue their interest in science; or asking students to connect concepts from Bio2 to the featured scientist's research.]*

To assess the impact of this curriculum on students' ideas about scientists and sense of belonging in science, *Bio2* students in both lecture sections ($n = 145$ students) were asked to respond to a three-question online survey before and after completing these Scientist Spotlights modules. "Pre"-survey data were collected during Week 2 of the semester, and "post"-survey data were collected during Week 14; identical survey questions were administered at both time-points. Students were reassured that there were no right or wrong answers and that any response they entered into the survey would earn 2 course-points (out of ~654 total course-points for the semester). One hundred and twenty-seven of 144 registered students responded to both the "before" and "after" surveys. Individuals' responses from each timepoint were compared using qualitative and quantitative methods (Figs. 1 and 2).

Results

Students' completing this Scientist Spotlights curricular intervention correlated with two main outcomes:

1. Students' descriptions of "people who do science" contained fewer stereotypical words and phrases after they completed the modules, compared to before they completed the modules; and
2. The number of students who agreed that they "kn[e]w of an important scientist to whom [they] could personally relate" increased. Correspondingly, the number of students who disagreed with the statement or selected the neutral ("I don't know") response both decreased.

Word-cloud analysis of the frequency of word-occurrence in students' descriptions of people who do science are shown for the "pre"-survey and "post"-survey (Fig. 1a and 1b, respectively). Figure 1 indicates a shift in students' conceptions. Responses before exposure to Scientist Spotlights featured stereotypical descriptors: specific disciplines, famous male scientists (e.g., Albert Einstein), and the association of scientists' being "old". In contrast, responses after Spotlights were less stereotypical: they included the female scientists featured in *Bio2*'s Spotlights (Catherine Drennan, Lydia Villa-Komoroff, and Nozomi Ando), indicated that scientists can come from diverse backgrounds, and mentioned attributes that make them relatable to college students (such as being passionate, persistent, younger, and enjoying their careers).

Figure 2 visualizes a sharp increase in students' levels of agreement that they "know of one or more scientist(s) to whom [they] can personally relate.", on a 5-point Likert-scale of agreement: "agree, somewhat agree, I don't know, somewhat disagree, or disagree". Before the Spotlights modules, 16.7% of students agreed with the statement, 40.2% "somewhat agreed", and 13.2% were

unsure (Fig. 2). After the modules, 54.3% of students agreed, 30.7% “somewhat agreed”, and 6.7% were unsure (Fig. 2).

Future Directions:

- Disseminate the 3 new Scientist Spotlights developed in this study via the *Scientist Spotlights Initiative* public database <<https://scientistspotlights.org/>>, hosted by Foothill College and San Francisco State University’s SEPAL (Science Education Partnership and Assessment Laboratory).
- Administer Scientist Spotlights modules and research surveys to Fall 2021 Bio2 students, with IRB approval (institutional review board protocol), to allow for publication.
- Apply for an NSF IUSE grant (Improving Undergraduate Science Education, from the National Science Foundation) to conduct follow-up studies.
- Refine qualitative codes to formally analyze students’ survey responses.
 - I developed a suite of emergent and *a priori* (Yonas, Sleeth, & Cotner, 2020) qualitative codes describing students’ explanations for their extent of agreement or disagreement with Survey Question #2 (personally relating to a scientist).
 - Future analyses with these codes will characterize what factors help CSUS students increase their sense of relating to scientists and belonging in science.

Figure 1 – Comparison of Bio2 students’ descriptions of “people who do science” before and after completing Scientist Spotlights modules: Word-cloud visualizations of the 250 words most commonly-occurring words in student’s responses to Survey Question #1 (“Based on what you know now, describe the types of people that do science”) were generated to identify preliminary trends for further qualitative analysis using emergent codes and themes. Responses that students authored before and after completing the Scientist Spotlights discussion modules are represented in Panel A and Panel B, respectively.

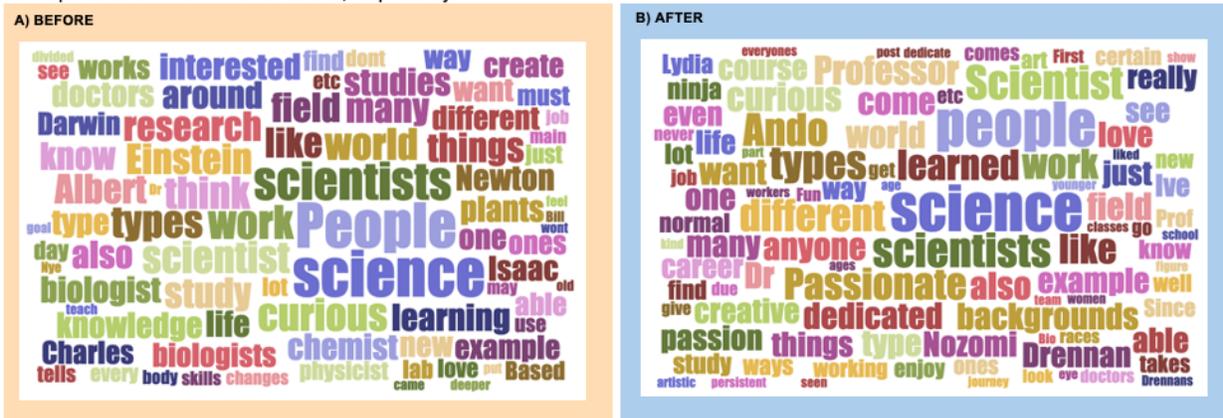
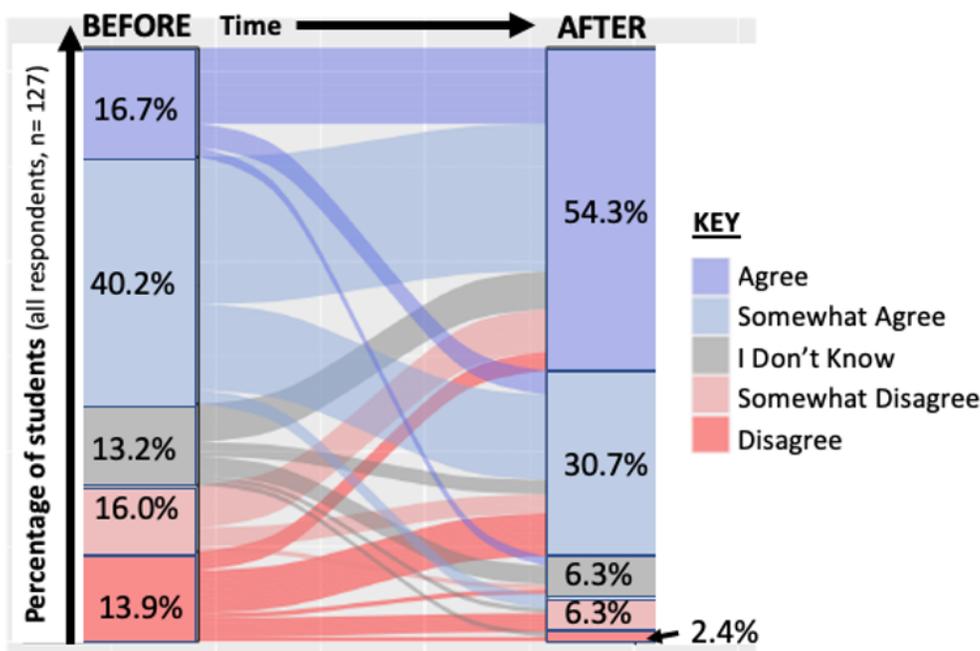


Figure 2 – Comparison of individual Bio2 students' levels of agreement that they “know of one or more important scientist(s) to whom [they] can personally relate” before and after completing Scientist Spotlights modules: Alluvial plots were generated to visualize changes in individual respondents' levels of agreement or disagreement with Survey Question #2 (knowing of at least one important scientist to whom they felt that they could personally relate). Ribbons between the “BEFORE” and “AFTER” axes are color-coded based on the individual's initial (“BEFORE”) response, and the thickness of these ribbons represents the proportion of respondents whose “BEFORE” and “AFTER” responses were in a given category on the 5-point Likert agreement scale: dark blue for “agree”, light blue for “somewhat agree”, gray for neutral “I don't know”, light red for “somewhat disagree”, and dark red for “disagree”. Responses that students submitted before and after completing the Scientist Spotlights discussion modules are represented on the left and right axes, respectively. The percentage of students who selected each of the 5 agreement-scale categories is indicated in stacked bar graphs adjacent to the “BEFORE” and “AFTER” axes of the alluvial plot.



References:

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