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CourseSource

Lesson

Diversifying and Humanizing Scientist Role Models Through Interviews and Constructing Slide Decks on Researchers' Research and Life Experiences

Ash T. Zemenick[1,2], Sarah C. Jones[2,3], Alex J. Webster[2,4], Elizabeth Raymond[5], Kate Sandelin[6], Natasha Hessami[5], Tim Kowalczyk[5], Marjorie G. Weber[1,2], and Caroline (Lina) Lund Dahlberg[7*]

[1]Department of Plant Biology and Ecology, Evolution, and Behavior Program, Michigan State University

[2]Project Biodiversify, Department of Plant Biology, Michigan State University

[3]Project Budburst, Chicago Botanic Garden

[4]Department of Biology, University of New Mexico

[5]Department of Chemistry, Western Washington University

[6]Department of Physics and Astronomy, Western Washington University

[7]Department of Biology, Western Washington University

Abstract

To maintain recruitment and retention, biology teachers face the challenge of finding relatable role models for their students. Our ever-increasing scientific knowledge has been facilitated by people from many different backgrounds, identities, and experiences. However, textbooks and lectures typically present researchers as one-dimensional people that live only to perform science. Highlighted scientists are also overwhelmingly members of majority and privileged backgrounds and groups. The lesson includes materials that will help students create their own slide deck of information about the research and outside interests of scientists at their own institution. The lesson also includes materials that can be used to help initiate discussions about representation and inclusion in science. The lesson introduces students to the research that is being done on their own campus as a way to humanize researchers. The lesson allows students to progress beyond being passive consumers of resources to themselves identifying relatable role models/role models from marginalized groups/backgrounds/identities. In general, the lesson helped students make personal connections to scientists at their institution, humanized scientists, that it made professors less intimidating, and increased their reported confidence in their ability to do research in the future. We provide templates, rubrics, and scaffolding materials from an undergraduate introductory course that instructors can directly implement to engage students in discovering the human side of the researchers on their own campuses and beyond.

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Supporting Materials: Supporting Files S1. Diversity and Humanizing Scientists – Optional jigsaw activity on persistence in STEM; S2. Diversity and Humanizing Scientists – Presentation for guiding a dialog on diversity and equity in STEM; S3. Diversity and Humanizing Scientists – Presentation to introduce Project Biodiversify and finding research; S4. Diversity and Humanizing Scientists – Researcher Slide Deck template; S5. Diversity and Humanizing Scientists – Email guide; S6. Diversity and Humanizing Scientists – Scientist Interview Summary Sheet; S7. Diversity and Humanizing Scientists – Project Biodiversify Slide Deck grading rubric; and S8. Diversity and Humanizing Scientists – Slide deck assignment for advanced students

***Correspondence to:** Western Washington University, 516 High Street, MS 9160, Bellingham, WA, 98225. Email: lina.dahlberg@wwu.edu

Learning Goals

Students will:

- Appreciate the importance of individual scientists' identities in the work that scientists do.
- Improve their ability to communicate results (from Science Process Skills).
- Understand the interconnectedness of science and society (from Vision and Change).

Learning Objectives

Students will be able to:

- Describe if and why they think diversity in science matters using data and their own experiences.
- Identify researchers in a field that they are interested in using online databases, search engines, and university webpages.
- Plan and conduct an interview with a researcher to learn about their personal experiences and their research.
- Participate in professional email conversations with researchers about their lives, backgrounds, and research interests.
- Discuss if and how research is integrated into their campus, and how students can be involved with research.
- Differentiate between a large-scale research question and a single piece of supporting data.
- Produce a succinct, stand-alone presentation.
- Provide peer feedback using a standard rubric.

INTRODUCTION

Role models are inspiring and provide support that allows for intellectual growth and development that is critical for recruitment and retention in STEM fields (1–3). Regular exposure to diverse, relatable role models can break down scientist stereotypes, which might otherwise be particularly harmful to students who identify as underrepresented and/or marginalized groups, identities, and backgrounds. Indeed, exposing students to the diversity of scientists positively affects students' interest and achievement in STEM (4–11). However, student access to diverse, humanized, relatable role models is limited; biology textbooks are particularly lacking racial diversity (12). Therefore, there is a need for students to be able to identify and engage with relatable role models in order to fully benefit from the scientific community.

Project Biodiversify is a resource whose central aim is to enhance human diversity and inclusivity in biology courses by building and crowd-sourcing materials and methods for biology instructors. Project Biodiversify's teaching materials include slide decks that feature the research and life experiences of biologists that self-identify as part of underrepresented or marginalized group(s) in biology. These slide decks facilitate easy inclusion of a diverse set of biologists into classrooms and lectures worldwide. Project Biodiversify is continually adding slide decks to their online repository; as of September 2020, the slide decks feature the science and experiences of 40 biologists (25 contemporary, 15 historical) who are Latinx, Black, Puerto Rican, Asian American, women, trans, gay, lesbian, bisexual, pansexual, neurodivergent (i.e., mental or neurologically function different from what is considered typical), and survivors of trauma and addiction. Project Biodiversify also offers seminars and workshops to train biology educators in inclusive teaching methods, thereby increasing student success, recruitment, and retention via inclusivity.

We created an activity where undergraduate students create slides using the Project Biodiversify template, researching and highlighting scientists on their own campus. For this activity, we did not limit students to learning about biologists. Although most of Project Biodiversify's slide deck contributions have been previously made by post-graduates, undergraduate students can build skills and self-efficacy by finding and learning about relatable and inspiring role models on their own. We used the Project Biodiversify slide deck template and model of humanizing and diversifying role models as a framework for students to learn more about the natural science research and researchers at their university. Because students may not see their own instructors or university faculty as approachable, it is important to humanize faculty (13). It is also important that students be able to highlight diverse faculty and staff as a way to find research and educational mentors with whom they identify (14). By asking students to interview researchers on their own campus, we expected students to gain familiarity with how to reach out to instructors and professors more broadly. We also hoped students would discover and appreciate the personalities, values, and interests of the researchers they profiled.

For this lesson, we situated learning about researchers at our institution as part of a larger theme of equity and inclusion of diverse scientists in academia. Western Washington University (WWU) is a majority-white institution with a diversifying student body. However, the rate of diversification of the faculty (the majority of the active research leaders on campus) lags behind that of the students. The lesson's broader focus on inclusion and belonging in STEM included reading a popular science essay on diversity in science (15) and analyzing a research paper on how race affects the career trajectories of researchers in biomedical fields (16). These activities provided an inroad to opening a facilitated discussion on race and identity in science, writ large, as well as at our own institution (17), which led to the question: "Who does research on our campus?" Students addressed this question by finding and reaching out to active researchers on our campus and interviewing them. Their findings were collated in the form of the Project Biodiversify slide decks that include data from and pictures of the researcher. Taken together, this lesson accentuates the importance of group work, formative feedback, peer evaluation, and iteration as part of the learning process, while also humanizing researchers.

This lesson provides a meaningful way for students to engage with researchers on personal and scientific levels and to enable researchers to provide a snapshot of their data and personality to the larger scientific community. This is especially valuable for educators looking to increase the representation of a diverse range of scientific identities in their classrooms. Future iterations of this lesson can include submitting slide decks about biologists to the Project Biodiversify website or changing the focus from contemporary to historical researchers.

Intended Audience

This lesson was presented as part of a seminar course for first-year and transfer students with STEM interests at a mid-sized regional university (Master's, but not PhD granting). Students generally had not declared majors but had indicated an interest in the natural sciences as part of their application to the university. Upon acceptance, the students in the seminar were invited to join the two-quarter long seminar course Understanding Scientific Research and Becoming a Student of Science. The course was run as three sections, each with 4-15 students per section. Each section was run by a different instructor. This lesson could also be successfully adapted for an online course experience, for science majors or non-majors (for example, in a science communication course), and even for graduate students (see "Modifications" section below).

Required Learning Time

This lesson can be run in three, one-and-a-half-hour class periods, with homework time allotted for students to interview a scientist on campus and work together to assemble the presentation slides (see Table 1). In this iteration, interviews were scheduled via email and took place for 35-60 minutes outside of class time.

Prerequisite Student Knowledge

Students should have a broad research interest that they would like to learn more about. If students will be interviewing scientists on their own campus, some knowledge the types of research in different departments is useful. Students were expected to be able to use an internet browser window to search for faculty research descriptions on departmental websites; at the non-major/introductory level, students did not need to understand how to use websites such as PubMed or Google Scholar. Students were provided with slide deck templates in a PowerPoint format, but were not given extra instruction in using PowerPoint, PowerPoint Online, or Google Slides.

Prerequisite Teacher Knowledge

Instructors should be generally aware of the breadth of research being done in a discipline, even if they do not know a large number of specific examples of research questions or data gathering methods. Instructors will need to have a good sense of email etiquette (to ensure that students can reach out to and receive responses from researchers). It is helpful if instructors can steer students towards researchers with diverse backgrounds or identities, in case students are unable to find them on their own. If students will be interviewing faculty on their own campus, instructors should be able to suggest alternatives (e.g., new hires, researchers with low internet profiles, researchers housed in departments that are not usually associated with their field), in case a specific researcher is not available for an interview.

Instructors should also have knowledge about issues of diversity, equity, and inclusion (DEI) in STEM. If instructors do not feel they have this prerequisite knowledge, we recommend several resources. First, instructors can find biologists from diverse backgrounds and identities at some of the following:

- Project Biodiversify Examples - slide decks featuring science and life experiences of diverse biologists
- DiversifyEEB - lists ecologists and evolutionary biologists who are women or underrepresented minorities
- Scientist Spotlights - assignments/activities that link course content to stories of counter-stereotypical scientists
- Skype a Scientist - database of scientists to connect with classrooms
- Black in the Ivory - amplifies voices of Blackademics
- 500 Women Scientists - amplifies voices of women scientists
- 500 Queer Scientists - amplifies voices of queer scientists
- If/Then Collection - media and resources that feature a diverse group of female STEM professionals
- on Twitter using #diversifySTEM #womeninSTEM, #queerinSTEM, #blackinSTEM #blackintheivory, etc.

Second, instructors who will facilitate a discussion of DEI in STEM (Supporting File S1. Diversity and Humanizing Scientists – Optional jigsaw activity on persistence in STEM, Supporting File S2. Diversity and Humanizing Scientists – Presentation for guiding a dialog on diversity and equity in STEM) should be comfortable and knowledgeable with these topics. We suggest the following resources for instructors, including perspective pieces, discussion tools, and workshops or other forms of professional development. David Asai's two perspective pieces "To Learn Inclusion Skills, Make It Personal" (18) and "Excluded" (18, 19) describe issues of bias and exclusion in STEM, as well as ideas for acknowledging and working to reduce personal bias. Robin DiAngelo's "Frames of Reference," and "Silence Breakers for Whites in Cross Cultural Discussions" (20) are helpful tools for facilitators and participants. Pedagogy discussions by Dewsbury, Brame, and Tanner, among many others (21–23) include detailed descriptions of the literature surrounding creating and maintaining inclusive classrooms. In addition, professional development workshops such as the Courageous Conversation series are enlightening, thought-provoking, and valuable, and provide important platforms for further self-reflection and action.

SCIENTIFIC TEACHING THEMES

Active Learning

This lesson incorporates active and inclusive teaching practices that are described in detail in Dewsbury and Brame, and Tanner (22–24) and active student participation was integral to the lesson plan. Active learning strategies involved in the lesson plan include a jigsaw activity, think-pair-share, group work, performing research, round-robin peer review, and presenting findings at the end of the course (see Lesson Plan for details).

Assessment

In order to determine if and how well students were attaining the learning objectives, we conducted a variety of formative and summative assessments. During discussions about diversity, equity, and inclusion in STEM, students participated in think-pair-share and quick-write activities. In some cases, students were asked to report out to the group, but some writings were kept private (Supporting File S2. Diversity and Humanizing Scientists – Presentation for guiding a dialog on diversity and equity in STEM). After introducing Project Biodiversify and the presentation assignment, students had time to discover researchers on campus; we used a "check-in" on our campus learning management system (Canvas) to ensure that students were able to find active researchers to contact. We also used Canvas for a summative assessment of student draft emails for grammar, clarity, and completeness based on the guide (Supporting File S5. Diversity and Humanizing Scientists – Email guide) and the progress of interview questions (Supporting File S6. Diversity and Humanizing Scientists – Scientist interview summary sheet). Importantly, both students and instructors used the grading rubric (Supporting File S7. Diversity and Humanizing Scientists – Project Biodiversify Slide Deck grading rubric) for evaluating the presentations before (formative assessment) and after (summative assessment) the final drafts were turned in, respectively. This process ensured that students clearly understood the evaluation process prior to submitting a final draft. We also held an impromptu verbal discussion around giving feedback following the peer-evaluation of draft presentations. Our combined use of incremental, low-stakes assignments and iterative summative assignments helped ensure that all students finished their presentations on time, and with enough scientific and personal information about each researcher to succeed in the assignment.

Assessment for Supporting File S1. Diversity and Humanizing Scientists – Optional jigsaw activity on persistence in STEM.

Students were given credit for participating in the jigsaw activity. Students were asked to turn in their worksheets so that instructors could ensure that all students had participated, even if they did not speak to the larger group during the exercise. This also allowed instructors to identify misinterpretations of the data and to correct pre- or misconceptions if necessary, before students got too far into the slide-deck assignment. Examples of possible answers are provided in the second half of Supporting File S1. Diversity and Humanizing Scientists – Optional jigsaw activity on persistence in STEM.

Inclusive Teaching

This lesson was designed to both introduce (or re-introduce) students to the importance of diversity in science, as well as to help students humanize researchers for themselves. We used

active learning to make the teaching and classroom activities as inclusive as possible (see "Active Learning," above).

This lesson challenged students to uncover their understandings about who can and does do research, while at the same time allowing them to learn more about a research area that particularly interested them. Students directly approached questions of bias and inclusion in STEM, both through discussions and by reflecting on social aspects of their own education related to their interests in science and research. In their interviews, students asked researchers about their personal journeys and struggles, which uncovered elements of humanity in faculty and instructors that students might not otherwise have learned about.

Student engagement was facilitated by instructors to ensure that students were able to contribute verbally (in discussions and think-pair-share activities), through writing (via quick writes), and in a variety of different roles (producing, giving feedback, revising) within their small groups. These activities were intended to ensure that all students were able to participate fully using their skills and strengths.

In accordance with the principles of inclusive teaching laid out by Kimberly Tanner (23), we employed a variety of low-stakes and collaborative teaching strategies to facilitate the group work. We were particularly careful to make sure that student-conceived norms for the classroom were applied and revisited throughout the course (22–24). This was especially important during discussions of inclusion, equity, and diversity, which introduced challenging descriptions of gender and racial bias that some students had not encountered in a classroom before.

Because student choice and interest drive motivation and ownership (22, 25–27), students had a wide range of topics to explore (anything that fell under the flexible rubric of "natural science", including both physical and life sciences). Based on their scientific and research interests, students formed groups, which were different from previous groups that they had worked with. Thus, within the classroom, the diversity of student interests and strengths became immediately clear to all participants.

This lesson explicitly addresses the roles that identity plays in scientists' lives and work. We used principles of inclusive teaching to ensure participation by all students at the same time that we explored how and why participation in science is still not universal (See "diversity in science" below). By providing students with choice, they also gained agency and self-efficacy in their own education and exploration.

Group work is inherent to this lesson plan. We acknowledge that group work can be prohibitively difficult for students with extracurricular pressures and responsibilities such as work, commutes, and family. Therefore, we recommend using smaller groups (3-4 students) rather than larger groups so that students within groups are better able to find times to meet outside of class. We also recommend forming groups with heterogeneity in mind; groups should have students with different levels of previous experience and competency levels in regard to the subject matter (28). For students from underrepresented backgrounds and identities, we recommend that whenever possible, groups do not have only one representative from that underrepresented background to prevent feelings of isolation (29).

LESSON PLAN

Course Mechanics

Course organization and group work

This lesson ran in three sections of the same course, during the same academic quarter. Each section completed the same activities during each class meeting time. Due to scheduling constraints, we spread some of the Class 1 sessions out across several class meetings (Table 1, Class sessions 1a-c). However, we have presented the Lesson Plan Timeline as it could be used in a three-class series. Students were encouraged to work synchronously via in-person meetings on out-of-class work (Table 1). Because student schedules could not always accommodate out-of-class meetings, the Lesson plan shows that work time for Class Session 2 and Class Session 3 included time for students to collaborate on work that they completed outside of class.

Instructor preparation

The three instructors met weekly for one hour over the duration of the course (10 weeks). Regarding this lesson in particular, the weekly meetings included discussions of expected complications, successes and difficulties, and changes for future iterations. All three instructors had either facilitated or participated in multi-part professional development workshops on diversity in STEM. One instructor had attended a workshop and seminar presented by Project Biodiversify.

Setting the Stage: Discussing the Importance of Diversity in Science

Diversity in science

We are aware that some courses may already have primed students for thinking about diversity in science. In our case, we used a jigsaw activity to open discussions about diversity in STEM and why it matters (Table 1) to prepare students for the Project Biodiversify slide deck assignment. This activity takes a significant amount of time beyond the rest of the Project Biodiversify lesson and does not directly address the goals of the lesson. Thus, we present the jigsaw as an optional precursor to the main lesson (Supporting File S1. Diversity and Humanizing Scientists – Optional jigsaw activity on persistence in STEM). It could also be used as stand-alone element or in combination with other curricula that investigate the importance of diverse perspectives in science. Alternatives to using the Jigsaw could include a guest speaker or curricula based on media that address diversity in science.

We asked students to read or look over two articles: the popular science article, "Diversity in STEM: What It Is and Why It Matters," (15) and the academic paper, "Decoupling of the minority PhD talent pool and assistant professor hiring in medical school basic science departments in the US,"(16); both were written by or in collaboration with Dr. Kenneth Gibbs Jr., a program director and grants manager at the National Institutes of Health. Students read the narrative article as homework prior to class (without accountability) but were not required to read the academic paper in its entirety. Students used analytical skills and group work to work through the Jigsaw activity (Supporting File S1. Diversity and Humanizing Scientists – Optional jigsaw activity on persistence in STEM), which highlights the lack of persistence of scientists who are Black, Indigenous, or People of Color (BIPOC). This jigsaw activity can be used as a hook

when discussing who the researchers, instructors, and professors are at a university.

Lesson plan for optional jigsaw activity

In a jigsaw activity, individuals within a group of students work to analyze different facets of a problem. Each individual becomes an expert in their smaller portion of the problem so that they can help the group work in a more informed way on the larger problem. Students will complete work on their own (Part 1), in jigsaw (letter-based) groups (Parts 2A, 2B, or 2C), and in a "home" group (Parts 3 and 4). The second half of Supporting File S1. Diversity and Humanizing Scientists – Optional jigsaw activity on persistence in STEM includes some suggested answers to the questions posed in the activity.

Students read the first section and answer the questions in Part 1 individually. This should take approximately 10 minutes. Students self-select a section (2A, 2B or 2C) to work on as a jigsaw (letter-based) group. The activities for each letter are essentially the same, so students do not need to read them before choosing jigsaw groups. Instructors can also assign students to jigsaw groups, if they prefer. Three-to-five students should work together in each jigsaw groups to answer the questions. In a large class, there may be 10-20 groups for each letter; in small classes, there will only be one group for each letter. Students work with their jigsaw group to analyze the data and respond to the questions, which should take 10-20 minutes. Instructors should rotate through the groups to clarify or give help and to ensure that groups are not bogged down in unimportant details. Students then form "home" groups to analyze the data in Part 3 and to answer the questions in Part 4. Instructors may want to encourage students to take 3-5 minutes to describe the major findings of their group. Students use their knowledge from their jigsaw groups to work collaboratively on the final data set and questions. This should take 5-10 minutes.

If instructors would like to use this this activity to segue into the discussion surrounding Supporting File S2. Diversity and Humanizing Scientists – Presentation for guiding a dialog on diversity and equity in STEM, some prompts could include: in the US, will the diversity of faculty increase simply by increasing the diversity of PhD-holding scientists? (Answer: Not based on these data). What will increased diversity of PhD-holding scientists mean for representation of diverse backgrounds at colleges and universities? (Answer: there may be more PhDs from diverse backgrounds, but they will not contribute to diversity at the faculty level.) Do you think that representation in science matters? (Answers will vary, but this is essentially a lead-in to the discussion facilitated by Supporting File S2. Diversity and Humanizing Scientists – Presentation for guiding a dialog on diversity and equity in STEM).

Following the jigsaw activity, we facilitated a discussion about diversity and inclusion in STEM as a whole as well as at our own institution. The discussion can be run in the absence from the optional activity above, but such a discussion is an important lead-in to Project Biodiversify. The discussion can be led by following the slides and prompts in the presentation (Supporting File S2. Diversity and Humanizing Scientists – Presentation for guiding a dialog on diversity and equity in STEM). The presentation includes a place for class norms to be inserted: we highly recommend setting course norms, referring back to them frequently, and using them to frame this potentially contentious discussion. For instructors who may want additional resources for facilitating a discussion on race, diversity, equity, and inclusion, we recommend the resources described in the "Prior Knowledge" section above.

The introductory discussion using Supporting File S2 (Supporting File S2. Diversity and Humanizing Scientists – Presentation for guiding a dialog on diversity and equity in STEM) requires patience and thoughtful consideration by the instructor, who will act as a facilitator. Similar to other discussion-based activities, instructors can expect that students will need time to consider their answers and to build the courage to convey them. In the event that students are unwilling to share their answers out loud to the whole group, switching to a quick write or think-pair-share modality may be helpful. Below, we also highlight a few of our experiences, which may help instructors determine how they would like to lead this discussion. Students were encouraged to join the discussion via participation prompts (think of five scientists with a given identity: What was difficult about this exercise, and why do you think that was?), think-pair-share exercises (tell your neighbor the story of your name; share your experience with the class), and quick write reflections (What did you notice about your own thinking? Why do you think that diversity in science matters?).

Slide 3 of this presentation (Supporting File S2. Diversity and Humanizing Scientists – Presentation for guiding a dialog on diversity and equity in STEM) refers to the "Draw a Scientist" study that describes children's internalization of stereotypes of who scientists are. In our experience, many students will report that they picture a white male for all three examples. In some cases, students will report that they thought of a scientist that they know personally. In addition, when referring to Slide 7 (Supporting File S2. Diversity and Humanizing Scientists – Presentation for guiding a dialog on diversity and equity in STEM), students are able to identify scientists from the first two categories, but not in the final one. We find that honesty on the part of the instructor is important to both of these discussions. If the instructor also struggles (or struggled) with the exercise, it can be useful to talk about why it might be difficult to identify scientists from diverse backgrounds (for example, lack of representation in textbooks, media, faculty, and professional societies).

Project Biodiversify

Students are introduced to Project Biodiversify through an interactive presentation and the slide deck format (Supporting File S3. Diversity and Humanizing Scientists – Presentation to introduce Project Biodiversify and finding research & Supporting File S4. Diversity and Humanizing Scientists –Researcher Slide Deck template, respectively). Project Biodiversify is a resource developed with the goal of highlighting human diversity and inclusivity in biology courses. Instructors should find a couple of examples of published slide decks to show students. Students should also be encouraged to explore the slide decks on the Project Biodiversify website on their own. It is important to note that Project Biodiversify focuses on biological sciences and is a relatively new project that is designed to be continuously revised. A full diversity of identities or biological topics represented in the database is the goal and not the current state of the Project. Instructors should be aware of these gaps and communicate them to students as a motivation for students to help fill/bridge those gaps. It may also be helpful to point out that the Project Biodiversify template and instructions are on the website, but

that they differ somewhat from the template, interview questions, and rubric that are provided for this lesson (Supporting File S4. Diversity and Humanizing Scientists – Researcher Slide Deck template, Supporting File S6. Diversity and Humanizing Scientists – Scientist Interview Summary Sheet, Supporting File S7. Diversity and Humanizing Scientists – Project Biodiversify Slide Deck grading rubric). For modifications that include interacting directly with Project Biodiversify leaders, please see "Modifications", below. Instructors and students are encouraged to reach out to Project Biodiversify leadership for guidance, support, and questions, especially if they are focusing on biology researchers or hope to contribute slide decks to Project Biodiversify.

Who does research on our campus?

Based on shared interests, students should form groups of two-to-four people, who they will work with for the remainder of the assignment (Supporting File S3. Diversity and Humanizing Scientists – Presentation to introduce Project Biodiversify and finding research). Students are asked to take three minutes to do a quick write about their own research interests, which they can share out to the group in order to identify others in the class who have similar interests. Once groups are formed, students should begin thinking of how to identify researchers who they would like to interview (Supporting File S3. Diversity and Humanizing Scientists – Presentation to introduce Project Biodiversify and finding research). In order to help students brainstorm researchers on their campus whom they might like to interview, instructors should offer resources (department websites, college/university newspapers or newsletters, etc.; Supporting File S3. Diversity and Humanizing Scientists – Presentation to introduce Project Biodiversify and finding research). Because faculty websites, in particular, may not be up to date, it is helpful for instructors to be ready to use their own networks to help students find researchers in topics that interest them, or to steer students away from unfruitful avenues (e.g., researchers on leave, or those without active research programs).

Getting to Know You

Reaching out to researchers

Students are asked to interview researchers. The presentation (Supporting File S3. Diversity and Humanizing Scientists – Presentation to introduce Project Biodiversify and finding research) includes out-of-class instructions for students and refers them to the email guide (Supporting File S5. Diversity and Humanizing Scientists – Email guide). Students will need to coordinate within their group to decide who they will contact, draft emails, send them, and follow up; these tasks can be completed out of class though in-person meetings, over video conference, or via email and text. Student groups emailed three different researchers to ensure that they got an affirmative response from at least one person; most groups heard back from two or more researchers saying that they would be happy to be interviewed. We found it helpful to have students upload draft emails to the learning management system so that instructors could check for grammar and completeness. We also asked students to cc (carbon copy) their instructors on the emails, in case any miscommunications occurred between students and researchers. In order to ensure that student groups got at least one affirmative response, instructors privately (without cc'ing students) emailed the researchers to inform/remind them of the assignment; we did this to provide more impetus for researchers to respond to the students. For groups that had more than one researcher respond with interest in participating, student groups worked together to choose one interviewee.

Interviews

Students scheduled an interview with the researcher. Students used the Interview Summary Sheet (File S6. Diversity and Humanizing Scientists – Scientist Interview Summary Sheet) to guide their interviews and for taking notes. We asked students to look at this sheet as a group prior to the interviews and to come up with some questions of their own.

Additional questions provided by Project Biodiversify include:

- Why did you become a biologist?
- What is your favorite part about your job?
- What obstacles have you overcome to get where you are?
- What advice do you have for aspiring biologists?
- Do you feel that any dimension of your identity is invisible or under-represented/marginalized in STEM?

Following up

Following their interviews, students followed up with a thank you email, and well as a request for images that they could use for their slide deck, as described in Figure 1. Over the course of the assignment, students asked for a "work photo" of the researcher in the lab or the field, a "life photo" of the researcher doing something outside of their research/work field, a "photo

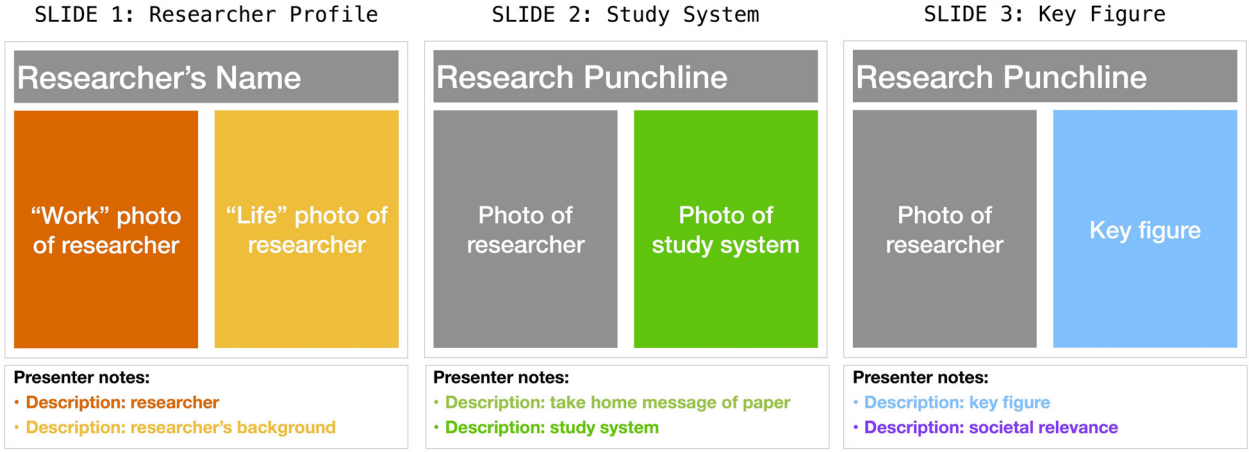

Figure 1: The Project Biodiversify slide deck template (modified from www.projectbiodiversify.org/materials). Students interview scientists to fill out the three different slides that profile a scientist's research and outside activities.

of the researcher" such as a head shot or official image, and two images of the research – an overview image and a figure presenting data. Many of the students in our course were first-year students and gathering and working with all of these images was sometimes overwhelming. In those cases, we worked with students to use as many images as necessary to provide a cohesive, cogent view of the researcher and their work and life.

Making a presentation

The Project Biodiversify template

Each Project Biodiversify slide deck consists of three slides (Figure 1). The first has information about the researcher, including a brief description about their research and a brief interview about the researcher's background (see below). The second slide introduces the study system. It has the punchline of the research and a photo of the study system. The presenter notes include the take home message of the research/paper and a description of the study system. Finally, the third slide shows the main result of the research by highlighting a key figure (data literacy). The notes include a detailed description of the figure, and also describes the societal relevance of the research (which has impact on retention of underrepresented groups in STEM; (14). For a better idea of the types of photos and descriptions typically included, see example slide decks.

During class time, students used the template (Supporting File S4: Diversity and Humanizing Scientists – Researcher Slide Deck template) to populate a rough draft of their slide deck. They used the answers from their interviews to construct presenter notes that function as a figure legend for each of the images.

The purpose of Slide 1 is to give an overview of the researcher. The title gives the name of the researcher, the photo on the left side shows a photo of the researcher doing their work, and the photo on the right side shows a photo of the research in an outside of work setting. This is because students often connect with interests of researchers, and not necessarily shared demographics (4).

The purpose of Slide 2 is to give an overview of the research being highlighted. The title of the slide gives the punchline of the research, and the photo of the researcher is maintained on the left side of the slide. The right side of the slide shows a photo of the study system. The caption for slide 2 describes an overview of the research to which the title/punchline refers; it also captions a photo of the study system and describes it in some detail.

The purpose of slide 3 is to overview a specific finding of the research and introduce a plot or table to challenge students with data literacy. As in the second slide, slide 3 maintains a title with the punchline of the research, and a photo of the researcher on the left side of the slide. The right side of the slide, however, now has a key figure or table that shows the data behind the research punchline. The notes provide a caption for the key figure and also a short description of its societal relevance, which is critical for marginalized and underrepresented groups in STEM (14).

Metacognition: What Do You Know That You Don't Know?

As they put together their slide decks, students discovered what they needed to complete their slide deck. Once they had identified the information or images that they needed, they wrote follow up emails to the researchers asking for them. One item on which many students had to work with the researcher was obtaining a key figure from a paper or unpublished work. This task was usually not done during the first get-to-know-you interview, and often required a follow-up email or appointment.

Revision

Students met outside of class time to revise and add to their slide decks. In particular, we asked students to make sure that their presenter notes were accessible to an outside, non-expert viewer. We also asked students to check with the researchers to make sure that presenter notes were correct.

Peer review

In class, students used the grading rubric (Supporting File S7. Diversity and Humanizing Scientists – Project Biodiversify Slide Deck grading rubric) to give feedback to peers. Individual students from each group reviewed the slide deck from another group (i.e., in a round-robin style). This structure ensured that each group received two-to-four individual critiques and no groups were left out. Peer reviews included comments such as, "I think you need more pictures here, I don't understand what this means" (in reference to an explanation of data), and "Nice Layout! I might try this!" Students were also provided with the grading rubric online so that they could review their own slide deck. Following the peer review, at least one course section held an impromptu discussion about peer review to address questions such as: "How did it feel to use the rubric? What was helpful about giving feedback to another group? What sorts of feedback were most useful for you and your group?" Following the peer-review, groups identified areas that needed more work, and any remaining information that they needed to gather for their slide decks. Revisions to create a final draft were completed outside of class by the student groups. Instructors received the final drafts as uploaded files on the Canvas Learning Management System (LMS).

Grading by instructors

The following products were graded by instructors for completion:

- Optional jigsaw activity (Supporting File S1. Diversity and Humanizing Scientists – Optional jigsaw activity on persistence in STEM). Paper copies were turned in and reviewed by instructor.
- Emails sent to researchers (Supporting File S5. Diversity and Humanizing Scientists – Email guide). Instructors reviewed the emails prior to sending and were cc'd on the correspondence.
- Interview questions (Supporting File S6. Diversity and Humanizing Scientists – Scientist Interview Summary Sheet). Students uploaded their interview questions to the Canvas LMS for review.

Draft presentations (turned in following peer review) and final presentations (Supporting File S4. Diversity and Humanizing Scientists – Researcher Slide Deck template) were graded by instructors using the supplied (Supporting File 7. Diversity and Humanizing Scientists – Project Biodiversify Slide Deck grading rubric).

Reading the articles by Dr. Gibbs, participating in discussions, and giving feedback in class were counted as class participation in the entire course grading scheme.

Contributing to the Community

Presentations

We originally planned to have students present their slide decks in class. However, the academic quarter in Spring 2020 came to an abrupt halt in the last week of the class due to the onset of the COVID-19 pandemic, so students did not have the chance to present. For further modifications in lieu of presentation, including uploading a slide deck to the Project Biodiversify website, please see "Modifications," below.

TEACHING DISCUSSION

Effectiveness/Student Reactions

Methods

Student reactions and assignment efficacy were determined by a seven-question student survey (Figure 2). Some of these questions were related to the Learning Objectives for this lesson (Q1-3), but they also directly addressed how students felt about the local importance of research, researchers, and the diversity of research and researchers on campus (Q4-7).
We asked the following questions of students:

Open-ended: How did your impressions of the following change as you worked on the presentation and poster assignment:

- Q1: Ability of undergraduate students to do research at WWU?
- Q2: Importance of research at WWU?
- Q3: Your ability to read and understand data?
- Q4: Diversity of science and scientists at WWU?

Select "agree," "somewhat agree," "somewhat disagree," "disagree," or "I don't know" for the following statements:

- Q5: I think it is important to learn about the people who teach and do research here on campus.
- Q6: I would be interested in learning more about the people who teach and do research here on campus.
- Q7: I know of one or more scientists at WWU to whom I can personally relate.

One of this paper's authors (who was not a course instructor) coded student responses as positive, negative, or neutral/mixed. Questions 1–4, which allowed open-ended responses, were coded according to criteria approved by all authors (Table 2). Questions 5–7 allowed the responses "agree", "somewhat agree", "somewhat disagree", "disagree", and "I don't know". "Agree" and "somewhat agree" were coded as positive, "disagree" and "somewhat disagree" were coded as negative, and "I don't know" was coded as neutral/mixed.

In addition to questions that related to the lesson's learning objectives and goals (Figure 2, Table 2), students were asked what aspects they liked and didn't like about the assignments. In general, student responses revealed that it helped them make personal connections to scientists at WWU, that it humanized scientists and made them less intimidating, and that they were more confident that they too could do research in the future. For example:

- *"I enjoyed the interviews the most. It helped me feel more comfortable about talking with professors and helped me to learn more about what they do as educators and as researchers."*

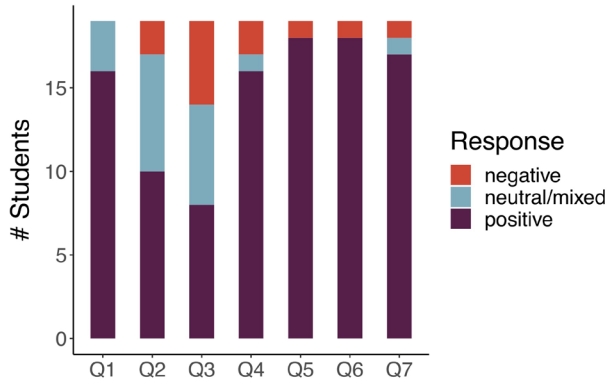

Figure 2: Student responses (n=19) to seven questions in a post-assignment survey. Question wording is in the text. Open-ended responses to Q1-Q4 were coded as negative, neutral/mixed, or positive according to criteria described in Table 2. Q5-Q7's allowed the following responses: "agree", "somewhat agree", "somewhat disagree", "disagree", and "I don't know." "Agree" and "somewhat agree" were coded as positive, "disagree" and "somewhat disagree" were coded as negative, and "I don't know" was coded as neutral/mixed.

- *"I loved writing about the pasts of the researchers, and how they got to where they are today. It was very inspiring. And it made it feel attainable for me."*
- *"I liked all of it: the exposure, the knowledge, and the confidence gained from the project. It allowed me to make a connection with someone I would like to work with. I can use them as a resource in the future. I now KNOW I will be able to do research in the future."*

Student responses to the query of what they did not like about the assignment frequently described the difficulty of scheduling time with scientists for interviews. Several students also noted a desire to do more in-depth presentations than the 3-slide or poster format would allow and/or to interview more than one scientist. Otherwise, the student suggestions for how the assignment could be improved were variable.

In the entire survey, there were very few negative responses to the questions, meaning that students rarely disagreed with the statement prompts from the survey; of the 19 students who responded and a total of 171 responses to all questions, there were only 11 negative responses and a few neutral/mixed reactions; the rest of the reactions were positive (Figure 2). Some representative/illuminating quotes include:

- *"I didn't realize how much research actually goes on here at Western until this quarter. Going through the lists of different professors researching different topics was eye opening."*
- *"This project (in particular: the interviews with professors) helped me learn how to actually get involved in undergraduate research."*
- *"I think my awareness of the diversity of scientists changed throughout this quarter as we talked about this a lot in our class… I also learned a lot more in this quarter about the significance of diversity in science and how important it is."*
- *"Doing this assignment definitely improved my ability to interpret and actually understand difficult data sets."*
- *"Honestly, this class made me feel worse about the diversity at [our school]. This is a good thing though, I see where we need to improve."*

Limitations of this Iteration and Suggested Improvements

Maintaining student focus

We found that students had difficulty placing equal value on questions about the scientific research and the personal interests of the researchers that they interviewed. In general, during the interviews, students chose one area or the other to focus on, which made filling in the template for the presentation more difficult. Students were able to follow up with researchers to fill gaps, as necessary. To mitigate this, we suggest having students spend time looking at the Project Biodiversify website or talking with the Project Biodiversify team. An alternative would be for instructors to modify the rubric to focus on either scientific research or personal interests of scientists. While this could make direct submission to the Project Biodiversify website less straightforward (See below, Modifications, Direct submission to the Project Biodiversify website), it could make the project more manageable for some students.

Modifications and Adaptations for Online Teaching and Learning

All aspects of this lesson could be provided as online curriculum. The lectures could either be prerecorded for asynchronous distribution or presented live via video conference. Discussions could also be facilitated for asynchronous courses using chat rooms or discussion boards. Especially for the optional jigsaw activity and introductory discussion (Supporting File S1. Diversity and Humanizing Scientists – Optional jigsaw activity on persistence in STEM, Supporting File S2. Diversity and Humanizing Scientists – Presentation for guiding a dialog on diversity and equity in STEM), instructors should monitor these discussions carefully, given the sensitive topics of diversity and privilege. The small group work (Table 1) can be accomplished in "breakout" groups or small, online, groupwork rooms. Feedback from peers and instructors can likewise be provided via email or small group discussions online. In addition, instructors could consider setting up small group meetings with individual groups to answer questions or work through problems.

This assignment was planned with an in-person presentation in mind, but the presentations were cancelled because of the of the COVID-19 pandemic. Upon further reflection after the end of the quarter, we feel that the presentation itself may not be as important as providing students with the chance to contribute to the scientific community by submitting their materials from their final presentation to the Project Biodiversify website. We suggest that unless public presentation is a learning goal for a course, publication on the website may be more motivating and long-lived than our original, planned presentation. For more information on uploading material directly, please see "Direct submission of materials to Project Biodiversify," below. Another alternative could be a scientist "informational flier" that could be printed and distributed, with the featured researcher's permission.

Modifications for Supporting File S1: Diversity and Humanizing Scientists – Optional jigsaw activity on persistence in STEM

Students can be asked to complete the first section of reading and responding to the initial set of questions on their own as homework. This would free-up approximately 10 minutes of in-class time. If the course is run synchronously and online, breakout groups for the home groups and the jigsaw groups may need to be assigned ahead of time. If the course is run asynchronously, students could work with their home groups on pre-assigned discussion boards, and then meet with jigsaw groups in a different set of discussion boards or collaboration tools.

In-person versus virtual interviews

Our students met in-person with researchers for their interviews and followed up via email with further questions. As many institutions have shifted to online formats, most students and researchers have become comfortable with online ("virtual") meetings. Students could be encouraged to set up online interviews or phone calls with researchers using video chat software. Although this could present difficulties for students with unreliable internet service, in some cases, it might ameliorate the scheduling difficulties that students experienced in setting up in-person meetings.

Off-campus scientists

Students may have a limited pool of scientists with shared or relatable identities and backgrounds at their home institution. In this scenario, we suggest that students are given the choice to contact instructors or researchers at different institutions to highlight for this assignment. The resources suggested in "Prerequisite Teacher Knowledge," above, may be helpful for instructors in suggesting off campus researchers to email and request to interview.

Historical scientists

The aim of this assignment is to connect students to instructors and researchers on campus. However, it is also impactful for students to learn about underappreciated heroes of the past. Many historical scientists from marginalized groups are not represented in textbooks or lessons. Students could utilize instructors' knowledge of historical scientists or books on the history of science to find role models to highlight that belong to underrepresented/marginalized groups. Instead of interviewing the scientist, students would instead write a brief biography about the scientist that speaks to their personal life, hurdles, and barriers that they overcame. For inspiration, see examples of historical figures highlighted, including an example of a successful student group's slide deck based on a historical scientist.

Upper Division and Graduate Courses

The benefit of identifying and learning about role models is not limited to lower division undergraduate students. So, although this assignment was designed for a lower division undergraduate course, it can be successfully implemented in upper division and graduate courses as well. In these situations, students may not need as much support in researching scientists or drafting emails. We are currently collaborating with instructors teaching a graduate course at Michigan State University's Plant Biology Department for this type of assignment (Supporting File S8. Diversity and Humanizing Scientists – Slide deck assignment for advanced students).

Direct Submission of Materials to Project Biodiversify

Instead of having students build slide decks, they can instead directly submit information about biology researchers to Project Biodiversify's online submission form. Please note that Project Biodiversify focuses on biological sciences, so information about researchers in other fields may not be ideal for submission.

In this scenario, students will not directly build slide decks because Project Biodiversify contributions are submitted through a Google Form, which generates slides that are curated by Project Biodiversify directors. Once slides are generated, Project Biodiversify directors reach out to the submitter and the biologist being nominated (unless they are historical) to ensure that they are comfortable with being featured. This process takes the burden of slide building off students and allows Project Biodiversify to maintain consistency across published slide decks. If instructors choose this approach, we suggest that they encourage students to submit information about historical biologists, as contemporary researchers may not consent to being highlighted on the internet or may not respond in a timely enough fashion for students to receive feedback and a grade in the course of one quarter or semester. Project Biodiversify is available to give seminars or in-class presentations, both virtually or in person, if instructors are interested in receiving instruction or background information directly.

Future Directions

This lesson offers additional benefits and outcomes that may be studied in the future. In particular, the open-ended questions asked of students offer additional insights that could be systematically researched. Follow up studies could determine whether students who complete this assignment are more invested in course material (e.g., Do they spend more time working on assignments or attend office hours more regularly?) Future studies could also address questions relating to recruitment and retention in STEM (e.g., Do students develop a stronger sense of science identity, a stronger intention to remain in STEM majors, or are they more likely to get involved in independent research projects on campus?).

SUPPORTING MATERIALS

- S1. Diversity and Humanizing Scientists – Optional jigsaw activity on persistence in STEM
- S2. Diversity and Humanizing Scientists – Presentation for guiding a dialog on diversity and equity in STEM
- S3. Diversity and Humanizing Scientists – Presentation to introduce Project Biodiversify and finding research
- S4. Diversity and Humanizing Scientists – Researcher Slide Deck template
- S5. Diversity and Humanizing Scientists – Email guide
- S6. Diversity and Humanizing Scientists – Scientist Interview Summary Sheet
- S7. Diversity and Humanizing Scientists – Project Biodiversify Slide Deck grading rubric
- S8. Diversity and Humanizing Scientists – Slide deck assignment for advanced students

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Table 1. Lesson plan timeline *Diversifying and Humanizing Scientist Role Models*.

Activity	Description	Estimated Time	Notes
Class Session 1a: Diversity in Science			
Discussion diversity in science	Students are prompted to think about who does science, who does science at their university, and why it matters	40-60 minutes (85-120 minutes if the jigsaw is used)	• Students should read the article "Diversity in STEM: What It Is and Why it Matters," prior to class time (15). • An optional jigsaw activity for analyzing Gibbs et al. (2016) is provided in Supporting File S1. Diversity and Humanizing Scientists – Optional jigsaw activity on persistence in STEM. This activity takes an additional 45-60 minutes. • Prompts for discussion, which can follow the jigsaw activity are provided in Supporting File S2. Diversity and Humanizing Scientists – Presentation for guiding a dialog on diversity and equity in STEM.
Class Session 1b: Project Biodiversify			
Introduction to Project Biodiversify	Introduction to the format of the Project Biodiversify format	15 minutes	• Presentation to introduce Project Biodiversify and the slide-deck format are provided in Supporting Files S3. Diversity and Humanizing Scientists – Presentation to introduce Project Biodiversify and finding research and S4. Diversity and Humanizing Scientists – Researcher Slide Deck template. • Students assemble into groups based on shared research interests.
Class Session 1c: Finding researchers on Campus			
Finding research interests and researchers on campus	Students form working groups	15 minutes	Students assemble into groups based on shared research interests
Out of class work			
Interviews	Students email researchers and complete interviews	Out of class time (2 hours, plus time for scheduling)	• Students identify researchers (guiding questions are provided, Supporting File S3. Diversity and Humanizing Scientists – Presentation to introduce Project Biodiversify and finding research, slide 6). • An email guide is provided in Supporting File S5. Diversity and Humanizing Scientists – Email guide; draft email reviewed and graded for completion by instructor. • Possible student interview questions and notes pages are provided in Supporting File S6. Diversity and Humanizing Scientists – Scientist Interview Summary Sheet; copy of interview questions graded for completion by instructor.
Class Session 2: The Slide-Deck			
Assembling Project Biodiversify slide-deck	Students use the slide-deck template to assemble a presentation	60 minutes	• A slide-deck template is provided in Supporting File S4. Diversity and Humanizing Scientists – Researcher Slide Deck template. • Students fill out the template. • Students identify missing information and/or data. • Students draft emails to ask for missing information and/or data.
Out of class work: Revision			
Revision of presentation	Students receive follow-up information and revise presentation	Out of class time (2-3 hours, plus time for scheduling)	• Students should ensure that their presentations adhere to the Project Biodiversify format. • Students should contact researchers if they are missing a "key figure" for their presentation. • Students should make sure that they understand the data provided by the researcher by writing a figure caption for the data. • Students should send their slides and captions to researchers to make sure that they have correctly represented the research and the scientist.

Activity	Description	Estimated Time	Notes
Class Session 3: Peer review and feedback			
Peer feedback	Students give each other feedback on their presentations using the grading rubric	30 minutes	• A grading rubric is provided in Supporting File S7. Diversity and Humanizing Scientists – Project Biodiversify Slide Deck grading rubric • Instructors print out presentations for students to review. • Students assess one another's presentations using the grading rubric and provide feedback. • Students receive instructor grades on draft presentations.

Table 2: Criteria for coding student responses to a post-activity survey, Questions 1-4. Each question relates to the general prompt: "How did your impressions of the following change as you worked on the presentation and poster assignment?"

Question	Positive	Neutral/Mixed	Negative
1. Ability of undergraduate students to do research at WWU?	Direct affirmation that this project improved their understanding of how to participate in research	Mixed or unsure responses, or that their understanding came from sources other than this project	Direct denial that this project changed their understanding
2. Importance of research at WWU?	Direct affirmation that this project improved their understanding of the importance of WWU research for scientific fields broadly	Mixed or unsure responses, or only noting the importance of student research	Direct denial that this project changed their understanding
3. Your ability to read and understand data?	Direct affirmation that comprehension had improved	A mix of affirmation and denial or lack of clarity about whether comprehension had improved	Direct denial that comprehension had improved
4. Diversity of science and scientists at WWU?	Direct affirmation that this project increased their understanding of diversity levels among scientists or the role of diversity in science, either generally or at WWU specifically	Mixed or unsure responses, or that their understanding came from sources other than this project	Direct denial that this project changed their understanding