

Scientist Spotlights and Data Nuggets

Biology and Mathematics Educators (BIOME) Institute
2021

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The BioSkills Guide Includes Elements of Diversity, Equity, and Inclusion (DEI) in Student Skill Development

- Identification and description of how systemic factors affect who becomes a scientist and how the process of science is conducted
- Describing examples of how scientists' backgrounds and biases can influence science
- Explaining how the process of science is enhanced by diversity

[BioSkills Guide: Development and National Validation of a Tool for Interpreting the Vision and Change Core Competencies](#)

Lack of Diverse Representation can Impact Student Views on the Types of People who Become Scientists and How They Conduct the Process of Science

- Increasing diversity of the student population we serve
 - Racial and ethnic minority groups
 - Marginalized gender identities and sexualities
 - First generation college students
 - Low income students
 - Part time students
 - Students who have caregiving responsibilities
 - Students with disabilities
 - Delayed entry into college
- Existing lack of representation of counterstereotypical scientists in the classroom and curriculum (Tanner 2009 and National Science Foundation 2021 and Cheyran 2009)

Exposure to Counterstereotypical Scientists in the Classroom Helps Diverse Students to See Themselves Represented in Science

- Embedding inclusive practices can promote a supportive climate for improving student motivation and persistence in STEM (Dewsbury 2019)
- Including representation of counterstereotypical scientists into inclusive teaching practices can promote students' sense of self-efficacy and belonging in science (Alfasi 2003)
- Scientist Spotlight activities have been used to blend inclusive teaching practices with course content coverage (Schinske 2016)

Schinske *et al* (2016) Examined the Effects of Increasing Representation of Diverse Scientists into Biology Classes in the Community College Setting

Small breakout rooms: what was one important point from the Schinske *et al* 2016 paper that stood out to you the most?

Discuss for 3 minutes

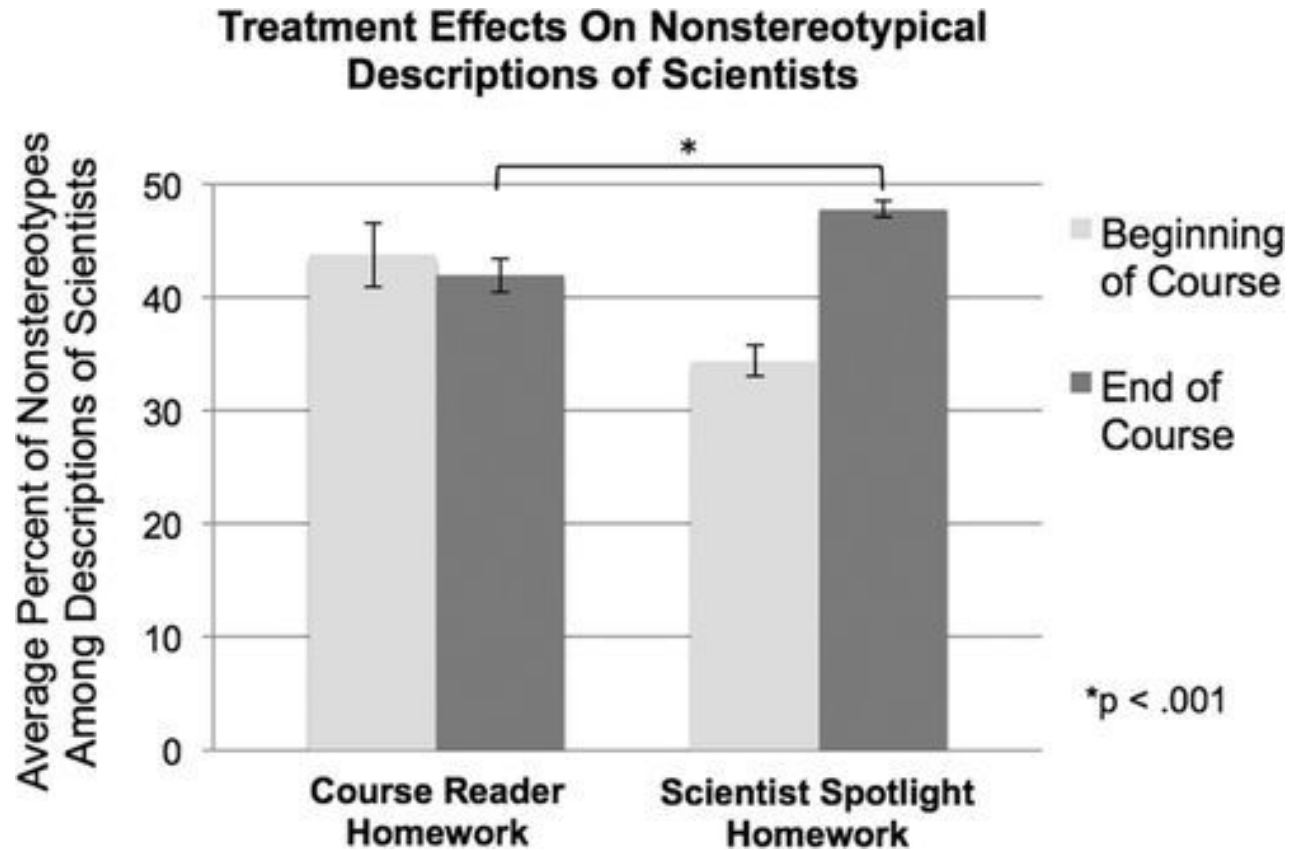


Figure 1. Average percent of *Nonstereotypes* among descriptions of scientists at the beginning vs. end of the course for Course Reader Homework and Scientist Spotlight Homework classes. Graphs depict weighted means to control for unequal group sizes and nonrandom assignment of students to treatment. Error bars represent SE.

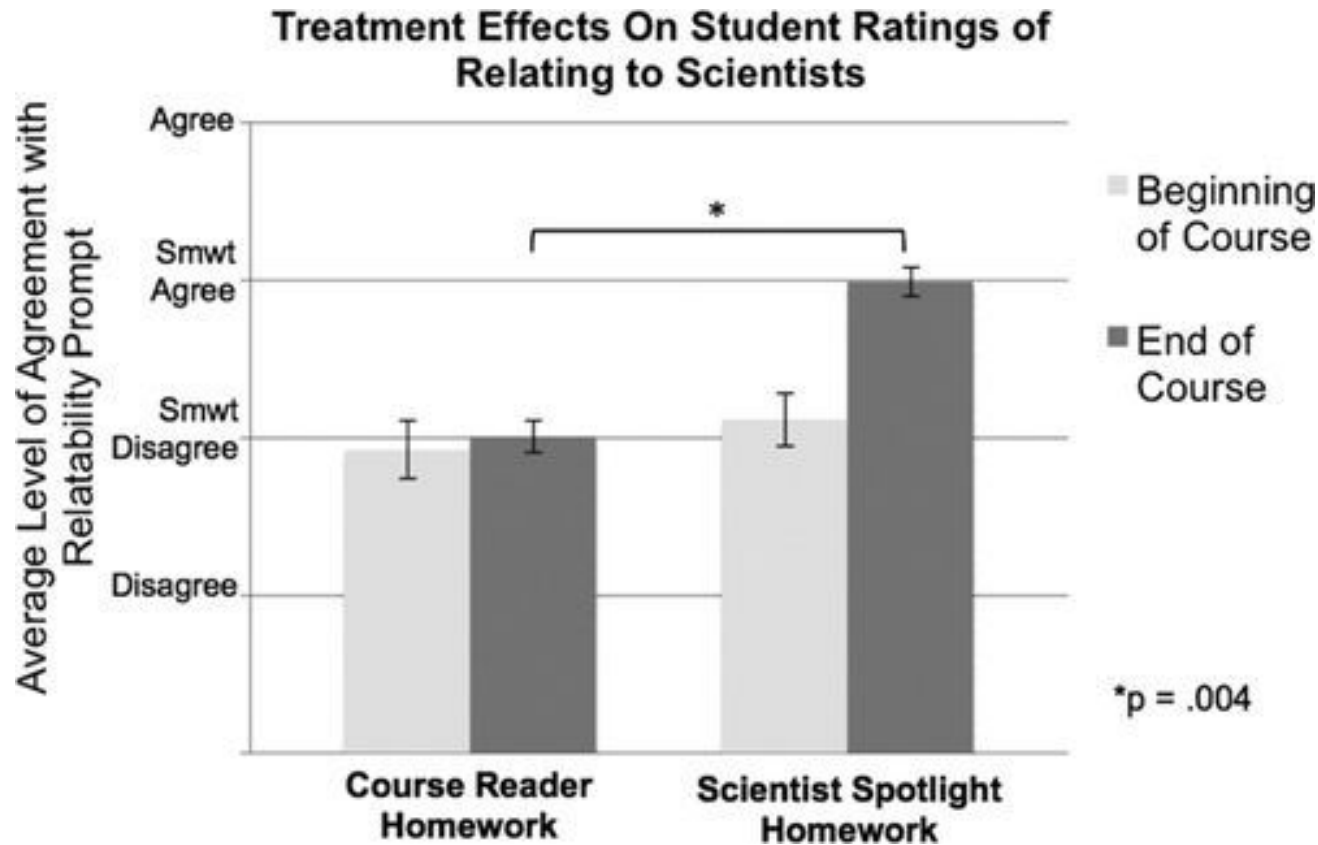
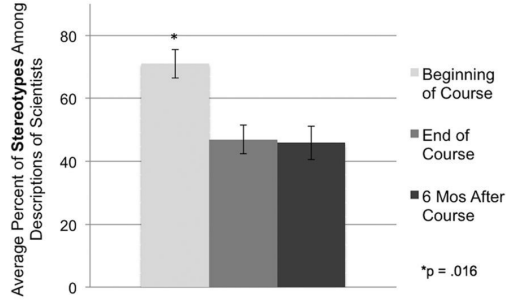
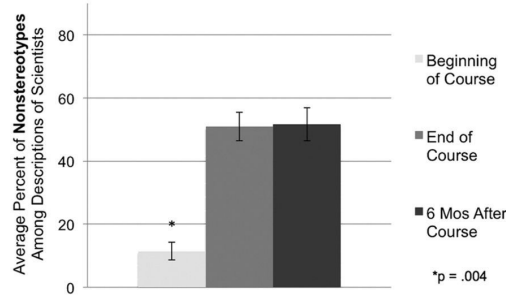


Figure 2. Average relatability Likert-scale selections by students at the beginning vs. end of the course for Scientist Spotlight Homework and Course Reader Homework classes. Graphs depict weighted means to control for unequal group sizes and nonrandom assignment of students to treatment. Error bars represent SE.

(a) Longitudinal Trends in Stereotypical Descriptions of Scientists Following Scientist Spotlights



(b) Longitudinal Trends in Nonstereotypical Descriptions of Scientists Following Scientist Spotlights



(c) Longitudinal Trends in Student Ratings of Relating to Scientists Following Scientist Spotlights

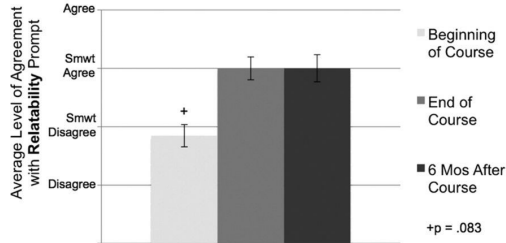
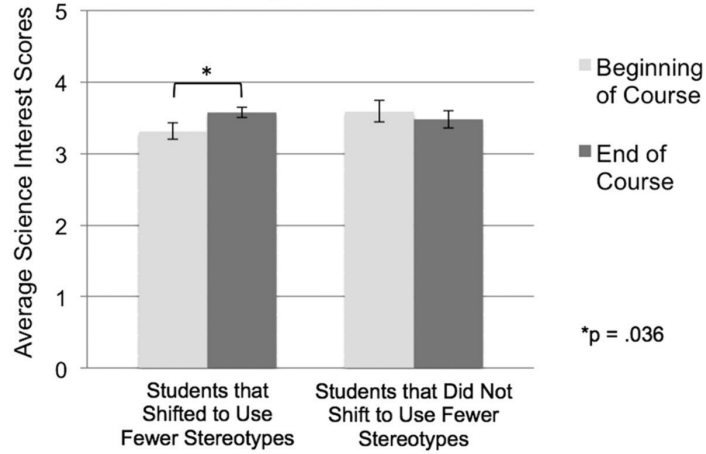


Figure 3. Average percent of *Stereotypes* (a), percent of *Nonstereotypes* (b), and relatability Likert-scale selections (c) in Scientist Spotlight students' responses at the beginning of the course, end of the course, and 6 months following the end of the course. Error bars represent SE.

**(a) Changes in Stereotypical Descriptions of Scientists
& Changes in Science Interest**



**(b) Changes in Nonstereotypical Descriptions of Scientists
& Change in Science Interest**

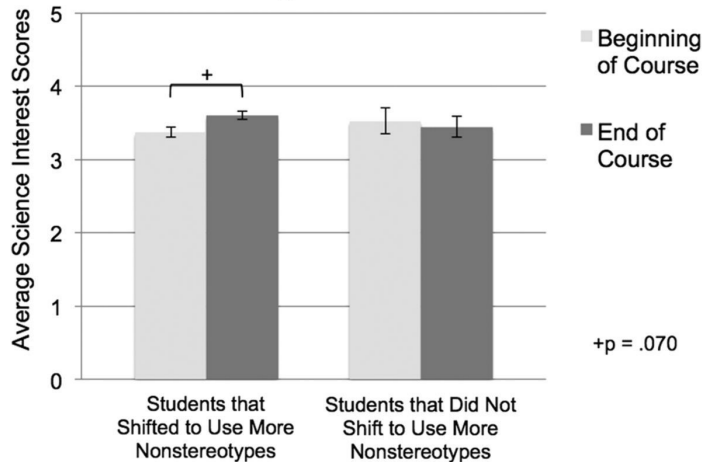


Figure 4. Relationships between changes in *Stereotypes* (a) and *Nonstereotypes* (b) to changes in Science Interest from the beginning of the course to the end of the course.

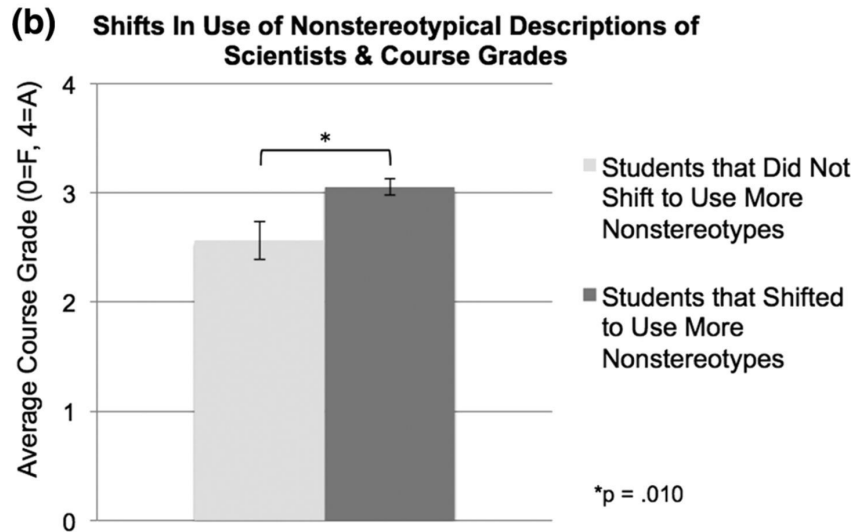
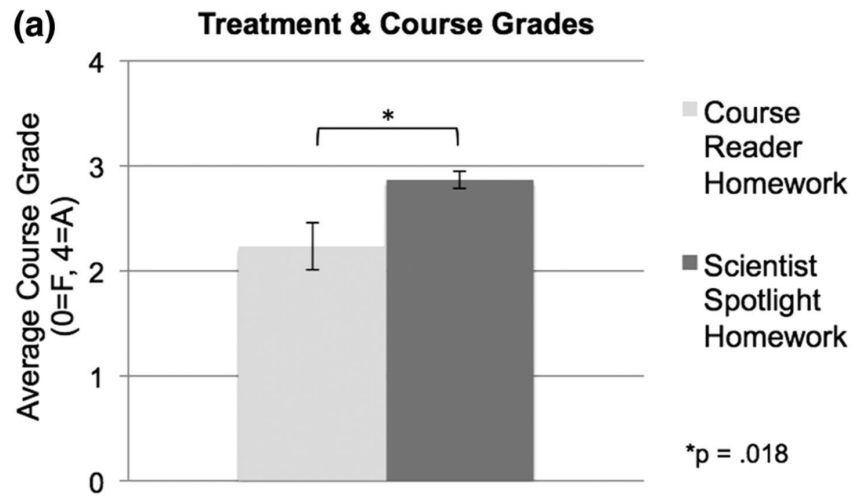


Figure 5. Average course grades (0 = “F,” 4 = “A”) for Scientist Spotlight Homework students vs. Course Reader Homework students (a) and for students whose proportion of *Nonstereotype* descriptions of scientists increased vs. did not increase (b). Error bars represent SE.

Diversity Syllabus Statements Help Create a Classroom Environment That Embraces DEI Perspectives

- Student buy-in for activities and assignments that promote diversity and inclusion
- Promote feelings of belonging, especially among students from underrepresented groups, to science
- Convey the message that students from all backgrounds are recognized in the classroom and that their needs are addressed in course activities

DEI Syllabus Statements: Educator's Pledge Example in a Community College Setting

- Community colleges have historically served a very diverse pool of students
- Varieties of ways to implement
 - Statement
 - Pledge
 - Informal note in course shell/syllabus/instructor website

DEI Syllabus Statements: Educator's Pledge Example in a Community College Setting

- Example:
 - No more than 1 page response to this prompt: Reflect on why you value diversity, equity, inclusion in your professional and personal life. Think about each of the terms separately as you craft your thoughts.
 - Embracing diversity is slightly different from understanding equity
 - Inclusive teaching practices are more active and intentional
- How do you express your commitment to these values, especially in your teaching and classroom environment practices?

Research-Supported Best Practices in Writing Diversity Statements

- Diversity statements should use aspirational language; avoid declarative statements that imply your institution/department/classroom is already an equitable and diverse environment
- Avoid using controlling messages; focus on personal autonomy
- Use very broad definitions of diversity and avoid “colorblind” statements
- Take a multicultural approach

Activity 1: Pairing Scientist Spotlights with Data Nuggets

- The goal of our FMN was to create Open Educational Resources that combined a Scientist Spotlight with analysis of actual scientific data created by the spotlighted scientist
- By adding the scientist's primary data, these materials can build the concepts/competencies of the course alongside social justice goals
- These materials varied widely in interview type (pre-existing vs. new, written vs. audio or video) and lesson style (lecture, activity, homework)

Activity 1: Pairing Scientist Spotlights with Data Nuggets

- Agenda for Activity 1:
 - Brief overview of two different example activities
 - Participants will browse activities and discuss which ones they might implement in their courses in breakout groups

Example 1: Using Nanoparticles to Deliver Cancer Drugs

- Part I: Brief overview of cancer and currently used cancer treatments (10 minutes)
- Part II: Description of experimental methods and analysis of data (10–15 minutes)
- Part III: Meet the scientist (10–15 minutes)

Part I: Brief overview of cancer and currently used cancer treatments

- Could be used after covering mitosis in general biology or as part of a unit on cancer
- 10 minutes

Why is cancer so hard to treat?

- Cancer is caused when normal, healthy cells undergo genetic mutations causing them to grow and divide too quickly, eventually invading areas of the body normally reserved for other cell types
- The big challenge of treating cancer: how do we kill cancer cells without killing too many healthy cells since they are so similar?

Part II: Description of experimental methods and analysis of data

- Students are told that different nanoparticles have different physical properties and that as a result, different cell types differ in how readily they will endocytose a given nanoparticle
- The goal of the experiment is to find a nanoparticle that is readily taken up by cancer cells, but not by healthy control cells; that nanoparticle could then be conjugated to a cytotoxic agent to selectively kill cancer cells

Experimental design

- Starve the cells overnight so they take up particles more readily
- Incubate the cells with fluorescently-labeled nanoparticles
- Wash away particles that are not taken up by cells
- Use a chemical called DAPI that binds to DNA to stain the nuclei of cells
- Use a microscope to see where DAPI and the nanoparticles end up

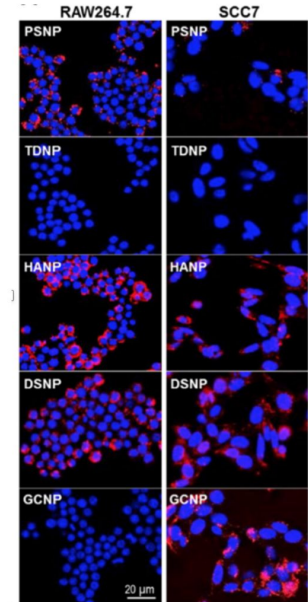


Part II: Description of experimental methods and analysis of data

- Students are shown a figure showing nanoparticle uptake in control cells (left column) and cancer cells (right column)
- Students are asked which nanoparticle would be best to deliver a drug specifically to cancer cells while sparing healthy cells

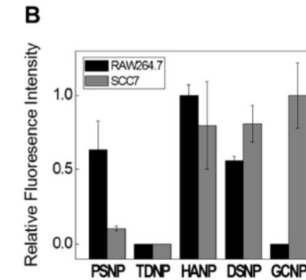
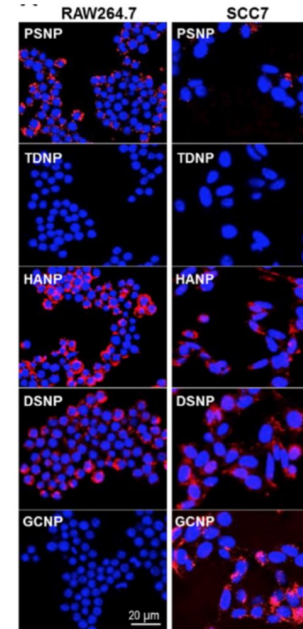
Experimental findings

- RAW264.7 = macrophages
- SCC7 = cancer cells
- Nanoparticles are stained red, nuclei are stained blue
- PSNP, TDNP, HANP, DSNP, GCNP are all different types of nanoparticles
- **Looking at the figure, which do you think would be the best nanoparticle to deliver a drug specifically to cancer cells?**



Part II: Description of experimental methods and analysis of data

- Finally, students are shown a bar graph generated using quantitative image analysis of the microscope image they previously viewed
- Students are asked to consider why it might be useful to convert image data into numerical data



Part III: Meet the scientist

- In a series of 3 video clips, students hear from the scientist who created the data they have seen, Dr. Hyeyoun Chang
- In the clips, Dr. Chang discusses her upbringing in Korea, her experiences as an international undergraduate student at a U.S. college, why she is passionate about science, how she has dealt with setbacks and sometimes not feeling confident in her abilities, and about why she finds scientific research rewarding

Did you ever feel like you didn't belong in science?



Part III: Meet the scientist

- At the end of the activity, students are asked “**What did you learn about Dr. Chang in these interview clips that surprised you or changed your perception of what it is like to be a scientist?**”

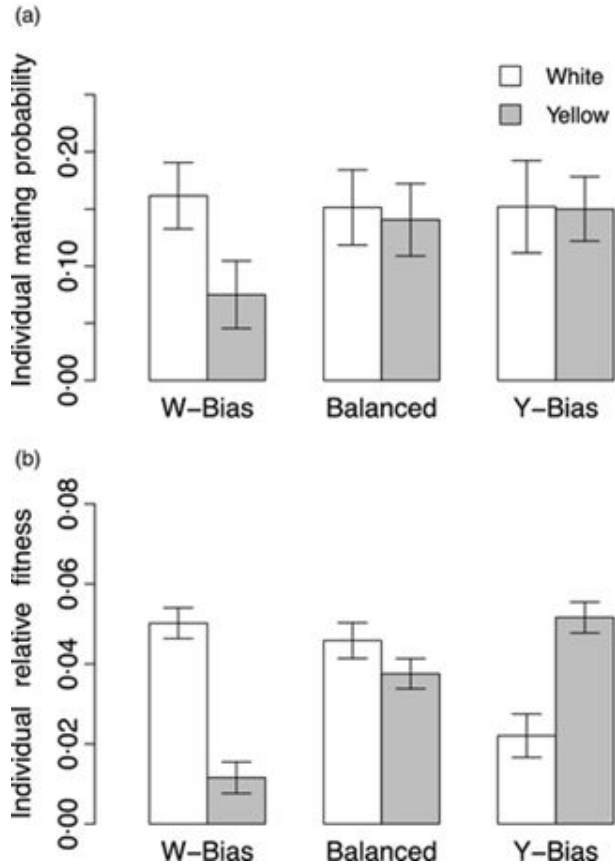
Example 2: Maintenance of Phenotypic Polymorphism

Single homework assignment to fit tightly within an existing Eco/Evo curriculum.

Includes:

- Summary and data figure from a study of moths
- Set of questions about conceptual material from the study
- Written interview (preexisting) with the PI, Dr. Swanne Gordon
- Prompts for written reflection on the interview

Part I: Summary, figure, and short answer Qs



Part II: Meet the scientist



Students' prompt is below (plus a short written bio)

1. Follow this link to read an interview with Dr. Swanne Gordon: <https://biology.wustl.edu/news/faculty-spotlight-swanne-gordon-assistant-professor-biology>.
2. After reviewing this interview with Swanne Gordon, write a ~200-word reflection on what you discovered. You might wish to address some of the following:
 - What does this interview tell you about the types of people that do science?
 - What was most interesting to you?
 - What questions do you have for Dr. Gordon after reading about her background and/or research?

Your Turn to Explore

Published materials:

<https://docs.google.com/document/d/1YbgSUnueSIXU2muedPysE0wXmxlylhnD/edit>

(link will be posted in chat)

15 minutes in breakout rooms

5 minutes to browse resources and identify potentially useful materials for your teaching

10 minutes in breakout rooms. To discuss:

- How do you envision using, adjusting, or creating new spotlight/nuggets for your courses?
- What experiences and concerns about spotlight/nuggets do you wish to share/discuss?

Activity 2: Lesson Implementation

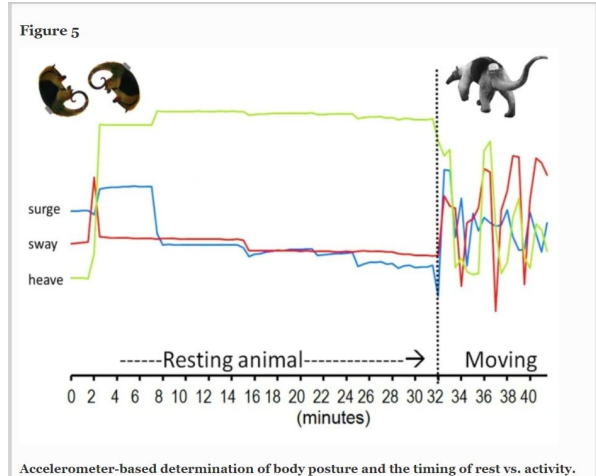
Overview:

- Brief introduction to 3 models of implementing Scientist Spotlights & Quantitative Analyses
- Connect Scientist Spotlights ~ Bioskills ~ Learning Objectives/Course Competencies
- In breakout room: explore questions related to implementation of Scientist Spotlights

Example: Intro. to Conservation Biology (online format)

Pre- and post-interview assignments included prompts from Schinske et al.

Chose BioSkills LO's focused on quantitative skills (e.g. create and interpret informative graphs and other data visualizations) and D/E/I (e.g. "Describe examples of how scientists' backgrounds and biases can influence science and how science is enhanced through diversity.")

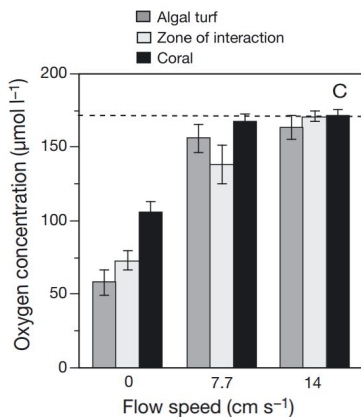


Dr. Danielle Brown - Observing the Unwatchable through Acceleration Logging of Animal Behavior

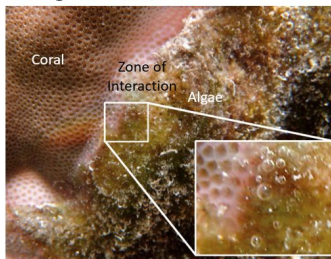


Example: Upper level coastal biology @ SLAC

- LOs:
 - “physical, chemical and biological variables in estuarine and coastal marine ecosystems” including methodology
 - BioSkills - process of science/quantitative reasoning
- “Tour” of coastal ecosystems (saltmarshes, oyster reefs, coral reefs, mudflats, etc.) - highlight scientists in multiple systems
- Multiple, shorter “Figure of the Day” format with whole-class (16 students) brainstorming, video that explains figure, and minute paper debrief



Biological Context:



Anya Brown - mechanisms driving coral/algal competition

Example: BIO II

Animal Behavior → Scientist Spotlight → Ecology

Scientist

- Dr. Christopher Schell

<https://www.tacoma.uw.edu/news/article/urban-ecologistsuperhero>

<https://magazine.washington.edu/feature/ecologist-christopher-schell-sees-himself-in-the-science/>



Method

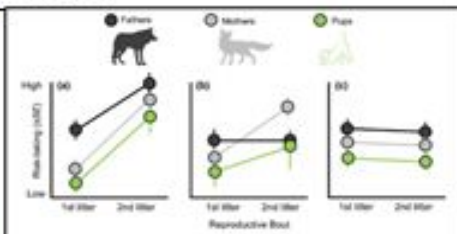
- Choose biographical article to read (5 min) & report back 3 interesting points
- Science Paper: Intro, Theoretical model, Research questions, Methods
- Students analyze 2 figures and compare results to theoretical model

Parental habituation to human disturbance over time reduces fear of humans in coyote offspring

Christopher J. Schell^{1,2} | Julie K. Young³ | Elizabeth V. Lonsdorf⁴ |
Rachel M. Santymire^{1,5} | Jill M. Mateo¹

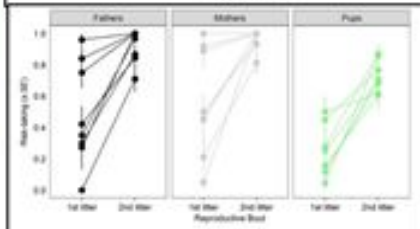
LOs

- Bioskill Competencies: Process of Science, Quantitative Reasoning
- Content: Apply terms/concepts from class
- Social Justice and DEI: Inclusive characteristics of scientists



Application & Exit Q

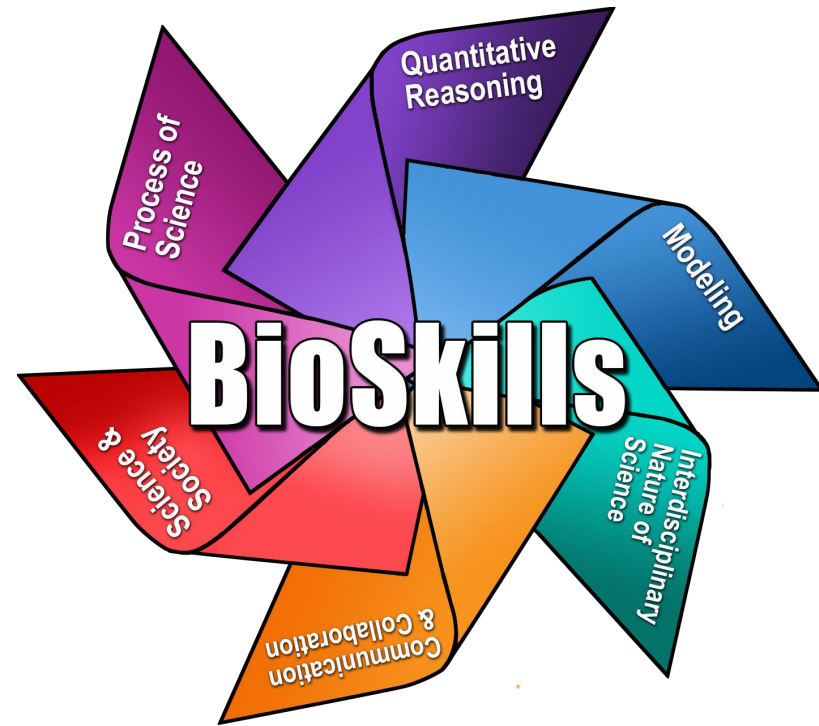
- Choose 1: How case study helped you understand a concept in animal behavior unit **OR** If continued research, what question to explore next?
- How perception of being a scientist has changed?



Activity 2: Implementation

How will these activities meet existing learning objectives?

Where will you add an activity to your course?



Short activity: Read through the bioskills and identify the relevant ones for your course that are linked to the lesson you picked in the previous activity (link and question in planning document)

Activity 2: Breakout Rooms

15 minutes in breakout rooms

Discuss the following and fill in your planning worksheet as you go:

- How do your existing course competencies tie into BioSkills?
- When do you plan on implementing the lesson (early/late in course)?
- Single vs. multiple spotlights?
- Do you envision a single short activity featuring a Sci. Spotlight or multiple activities?
- Any particular subject or skill areas for the activity (e.g., focus on ecology/conservation/quantitative skills/scientific method)?

Activity 2 Debrief:

Reflect for a couple of minutes, then answer one of the following questions in the chat:

- 1) What **excites** you about using scientist spotlights with quantitative/data activity?
- 2) What **worries** do you have about incorporating this into your course?
- 3) What do you **need** to get started?
- 4) What would be your next **step** to implement one of these lessons?

Wrap Up: Overview

How do students respond to Scientist Spotlight activities?

Opportunities to develop your own Scientist Spotlights & Data Nugget activities

- Fall working groups through BIOME
- Future Faculty Mentoring Networks like the one that generated many of the activities reviewed today

Coming soon: NSF-funded BioGraphI Research Coordination Network

Responses of students to Scientist Spotlight activities

Sophomore-level Ecology course in a 4-year primarily undergraduate institution

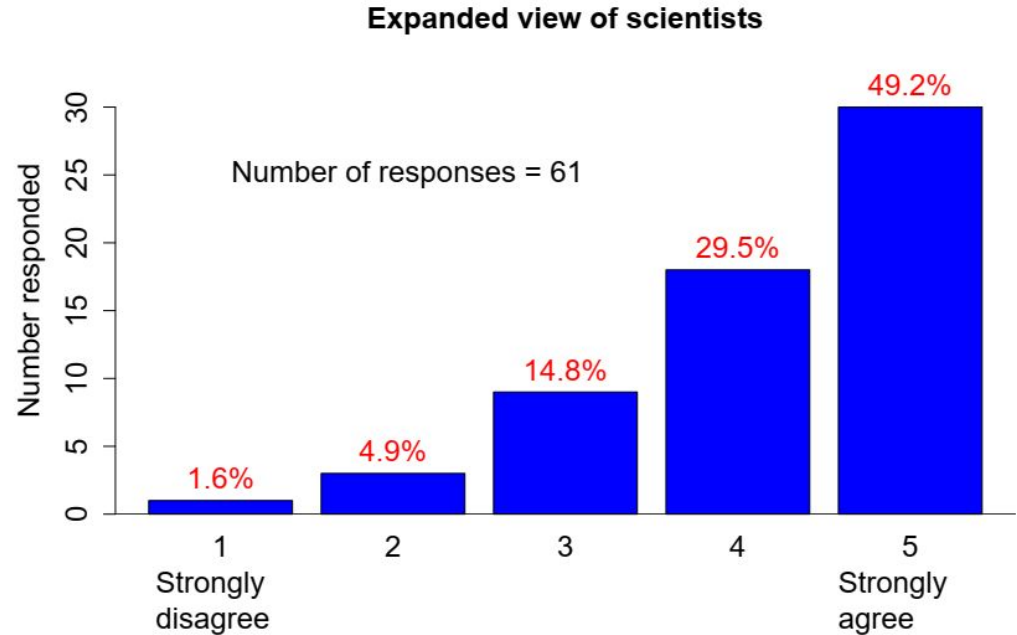
3 Scientist Spotlight assignments (weeks 4 (lizard cold tolerance), 9 (urban stream invaders), and 12) coupled with data interpretation/primary literature activities carried out in groups; students responded individually to similar prompts for each scientist:

1. What personal challenges did Dr. X face in his/her path to science? What was your reaction to his/her experiences? [this question varied a bit among scientists]
2. What did this blog post & video tell you about the types of people who do science? Has reading about his/her views and learning about the experiences of other scientists we have encountered in this class affected whether you personally relate to any scientists?
3. If you could ask Dr. X any question about his/her life or research, what would it be?

Responses of students - expanding their view of scientists

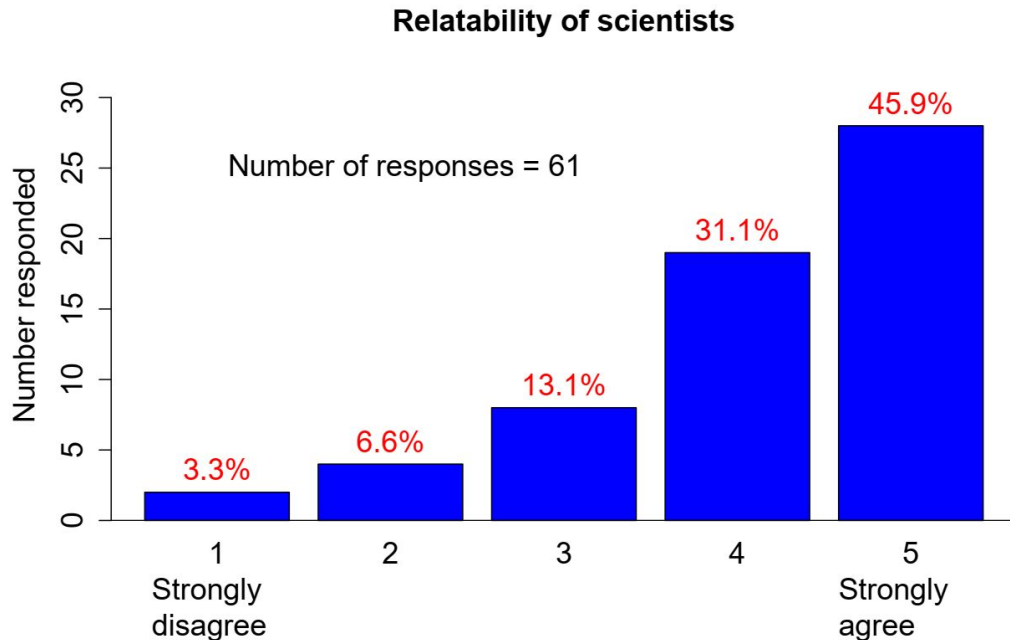
The scientist spotlight assignments expanded my view of the types of people who do science

End of semester anonymous course survey poll, 2 sections of Principles of Ecology (Biol 203, spr 2021)
Geneseo IRB#202021052



Responses of students - ability to relate to scientists

Reading about the scientists featured in the scientist spotlights helped me to better relate to scientists and/or see myself as a scientist.



Student comments: appreciating diversity of people who do science

... I think they really helped show ALL the people in science, which is important to move forward for social justice.

I think the scientist spotlight assignments were a good way to integrate diversity into the course.

Very good for gaining more perspectives and is an exceptional way to incorporate DEI learning objectives into a course .

interesting to learn about their backgrounds and their journey to becoming scientists

Student comments: opening eyes to influence of racism

- We learned about some really amazing scientist[s] and how brave they are for sharing their experiences. Without the science spotlights I would have never known what is going on in the community and the hardships they face.
- I knew there were challenges that the BIPOC scientists faced, but reading first hand encounters really was a eye opener and makes me appreciate what I have and makes me want to advocate for change in the science community.
- I appreciated learning about the stories of BIPOC scientists. There are barriers that an individual (being white) will never understand for others. This activity helped to expand my knowledge on the topic, but more research is clearly needed to even try to fully grasp the struggles that BIPOC scientists face. Those activities did spark an interest that i may not have found otherwise.

Other student comments & criticisms

Process of doing research: I better understand how research goes and now have gained interest in it for the upcoming fall semester!

Uncertainty about goals: It made me feel better realizing that a lot of scientists didn't know what they wanted to do when they came into college.

One criticism - repetition

They were easy to watch but I felt they were all pretty similar to each other

Very repetitive but was moving when reading their back stories.

I really enjoyed reading and hearing the different perspectives but the actual assignment questions got to be a bit repetitive.

Responses of students to Scientist Spotlight activities

Introductory Biology in a 4-year primarily undergraduate institution

One Spotlight activity at the end of the semester (Data on Dead Zones and a Scientist Spotlight Featuring Benjamin Negrete, Jr)

1. What is something that you learned today that you would like to share with someone outside of the class?
2. What did you learn from today's activity about adaptation to hypoxia, interpreting graphs, environmental impacts of human activities, conservation?
3. What new questions do you have after today's activity?
4. What did today's activity tell you about the types of people that do science?

Students shared reflections on identities of scientists when given a choice of reflection topics

43% of responses included a reflection on the identities and attributes of scientists or relatability of Ben Negrete

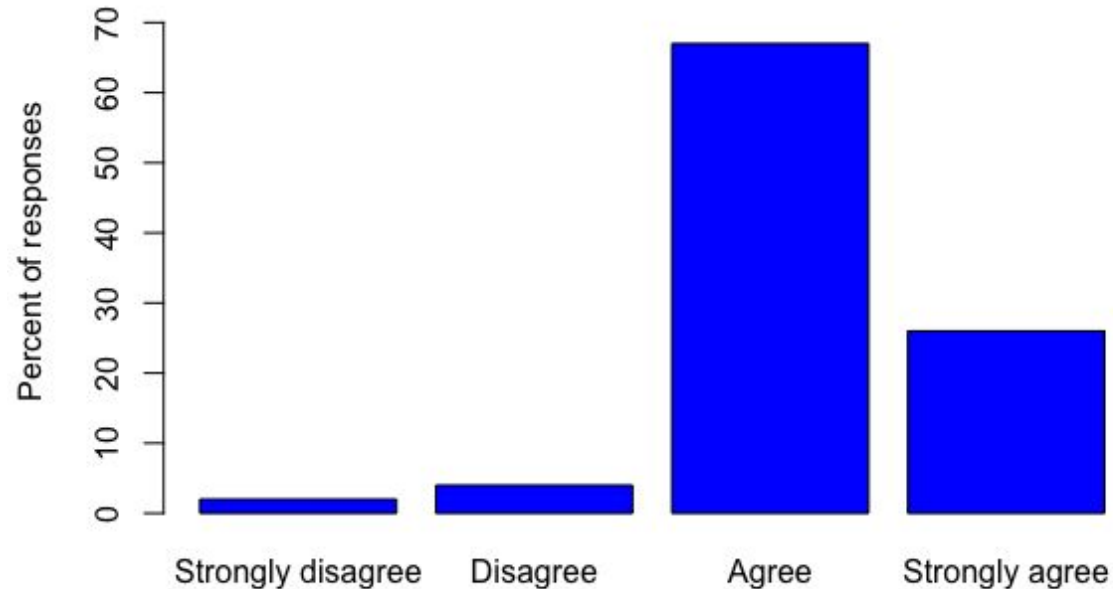
22% of responses mentioned what was learned specifically about graphing

59% of responses mentioned what was learned specifically about biology content (adaptation to hypoxia and environmental impacts of human activities)

Students gained data literacy skills

Rate your level of agreement to this statement:

I can now interpret data and figures from research studies conducted on the impacts of human activities on biological processes.



Reflection assignment
General Biology (Biol 119,
spr 2021)
n = 46 respondents
Geneseo IRB#202021052

Interested in developing your own lesson as an OER on QUBES?

Upcoming opportunities --

- Fall working groups through BIOME this year (2021)
- Could continue the work in a spring Faculty Mentoring Network, too (like the one that generated many of the activities reviewed today)

Interested in developing your own lesson as an OER on QUBES?

Coming soon: NSF-funded BioGraphI Research Coordination Network

- Biologists and Graph Interpretation (BioGraphI) will lead Faculty Mentoring Groups on QUBES to generate OER lessons with data literacy learning objectives and that highlight the work of counterstereotypical scientists
- First Faculty Mentoring Group in fall 2022
- Link for more information: <https://tinyurl.com/4f2wc9cx>

Thank you for attending our workshop!

Questions?