Unit 1 - Data Analysis, Underrepresentation

Analyze data to determine the representation status of people in sciences using a scientific-method type analysis of real numbers: make hypotheses, examine them through posted numbers, and reflect on possible causes.

NGSS connections: ***Practices:*** *Asking Questions and Defining Problems; Analyzing and Interpreting Data; Engaging in Argument from Evidence; Obtaining, Evaluating, and Communicating Information;* ***CCCs:*** *Patterns; Cause and Effect; Systems and Systems Models.*

Starting point for instructors

- Do Unit 0 - Setting the Stage before this, and review norms if needed
- Depending on student preparation, review graph-reading.
- Discuss demographics categories.
- We ask students to answer the following questions about the content and culture of science:
    1. What would proportional representation in science look like? Does it exist?
    2. What are possible reasons for it to not exist in our field?
    3. What can we determine from data that supports our hypotheses? What can we not determine?
    4. What would we need in order to get closer to answering our questions?

Pre-Lesson Student Exploration / Bell-Ringer

Before coming to class/at the start of class, students need to:

Write: How would you describe/draw a scientist? How do they dress? What language do they speak? What do they do? Who do they talk to?

In-Class Investigations

Discuss/Predict: Are some groups of people underrepresented in science? What data would we need to determine whether a group was properly represented in a given field? How would we analyze that data? [15-25 minutes]

Pie Charting: Give students a graph (pie chart, etc.) of the US populations broken down by demographics. Then give them an empty circle representing the community of physicists/chemists/biologists/etc., and ask students to make a pie chart - before sharing data - representing how they think the current population of the physics community identifies. Compare their pie charts with one of these: Physics, Chemistry, Bio-Med, Engineering.

Stand Up Slips #1: Assess patterns in thinking about underrepresentation [10-20 minutes]

Stand Up Slips (see the notes on this mode of engagement if you haven't used it before.)

Please check each statement that applies. Please be honest.

a. _____ Before starting this project, I had noticed a proportional lack of Black Physicists/biologists/chemists.
b. _____ I believe that this lack is a problem
c. _____ I believe that the reason(s) for this lack is/are a problem
d. _____ I think I could realistically do *something* that narrows the lack of Black scientists
e. A mistake I've made when talking about race is: (please write clearly *on the back*)

Instructor Note:
While we elicit common perceptions of scientists, we're also asking students to think about their roles in promoting changes. It's feeling out students' potential comfort and participation in upcoming class conversations.

Discuss: Why is there a difference between the general population and the science community? [10-15 minutes]

- Writing: What are all reasons that someone might say under-representation exists? Put differently - why is there a difference between the general population and the physics/chem/bio/etc. community?
- Share hypotheses, write them on the board:
  - Group them by "external" (the effects of society) and "internal" (the effects of values held by underrepresented community in question)
  - Ask a student to type up or photograph results, for sharing and later discussions

Stand Up Slips #2: Assess current reasoning for underrepresentation [5-10 minutes]

Please check each statement that applies. Please be honest.

a. I believe the relatively low numbers of physicists/chemists/biologists who are Black is caused by:
b. _____ some racial difference in aptitude for science
c. _____ lack of effective role models for Black students interested in science
d. _____ among freshmen, a smaller percentage of Black students are interested in studying science
e. _____ discrimination in the physics/chemistry/biology hiring process against Black applicants
f. A thought I wish I could share with everyone is: (please write clearly *on the back*)

Post-Lesson Homework

Explore a hypothesis

- Choose a hypothesis from the list we generated in class, a possible explanation for the disproportionately low amount of Black scientists. Explain specifically how this could impede potential Black scientists.
- Use the resources below (or others) to try to address its validity. Is it actually true, or do we just *think* it's true? Can you *cast doubt* on its validity, especially internal hypotheses?
- Bring in the statistics/trends you find that seem relevant (be sure to document your sources) Some key points:
    - Work in terms of %s, not absolute numbers (populations are different size)
    - Compare %s between races – how are the stats different for black/white, etc.?
    - Remember what you're trying to explain (both the question and hypothesis)
- List possible interpretations. Make sure you identify potential complexities: in what way does the data tell a more complex story than simply confirming your hypothesis?
- Explain what you believe the significance of the results to be. Does it point to a cause that is internal to the Black community or external (or both/neither?)
    - You should know: there is a documented tendency ("confirmation bias") to see data as confirming what you already believe, especially if it is ambiguous.
- Lastly, design an experiment – what census-type question would you want to ask to try to get to the bottom of the low number of Black scientists? Who would you ask it to?

Homework Debrief: Hypothesis exploration

Debrief (note that this combines well with Unit 2 - Meritocracy)

a. Students write on a whiteboard/paper:
    i. Which hypothesis did you explore?
    ii. What's one piece of information you want to share?
b. Students look around the room at everyone's shared information
    i. Writing: Did you see anything that surprised you? Discussion.
    ii. Discussion: did anyone find any that seemed to disprove a stereotype?
        1. Research finds that many stereotypes are not true
        2. Thinking of 'counter-stereotypical examples' can help erode stereotypes
        3. I sometimes use this as a chance to introduce Unit 2 - Stereotype Threat.
        4. Interested students can read some of the Resources below
c. Discussion: what does this tell us about the nature of science culture?

Resources

- Lesson Plan Resources
- *Women, Minorities and Persons with Disabilities in Science and Engineering* report (2019)
- Underrepresented Minorities in HS Physics report (American Institute of Physics) (2012 data)
- Undergraduate representation in physics (American Physical Society) (2017)

Notes from the Authors

1. Some worry that naming under-representation might cause students who came from those groups to feel more alienated. Research (one, two) suggests that the opposite is true.
2. We think it's important to frame the hypothesis formation as "what's something that *someone might* say" instead of "what's something *you believe*". The goal is to bring everything out for consideration, even the dangerous-feeling ideas, so that toxic ideas can be addressed and put to rest. If students are avoiding dangerous ideas - like the ideas that certain groups don't value school as much, consider adding it yourself.
3. That said, it's critically important that toxic ideas be shown immediately and powerfully to be false: Be sure you are ready to address these ideas if they don't come up; there's plenty of research out there to support this.
4. In debriefing the students' research findings, don't get too far into the weeds of any one statistic but, instead, focus on the fact that it's hard to rule many hypotheses in or out (based on one night's work, at least). Get students to consider "what if the under-representation told us something about society instead of those individuals?". (Not to believe it, but to explore it.) Getting too far into any one hypothesis makes that goal harder to reach, though some exploration of their work helps promote discussion and students' work to be recognized.