Designing and Assessing DEI Learning Outcomes in a Chemistry Course

A study conducted in a small General Chemistry class at Front Range Community College

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Introduction

Inclusive teaching practices involve a student-centered approach which is responsive to all intersecting social identities and lived experiences of students in the classroom. These practices should be embedded in every aspect of how one prepares to teach and engage with students and empowers student to make requests for support or to share their unique views on the content.

Student learning outcomes describe the knowledge, skills, attitudes, behaviors and values that students should demonstrate by the end of a course or program of study. Identifying and clearly articulating learning objectives centered around diversity, equity and inclusion (DEI) is critical in designing an in-depth learning experience, providing a critical lens through which students construct knowledge. When creating DEI learning outcomes, the instructor needs to make their learning outcomes transparent to students and connect them clearly to their assessment measures.

This study describes the design and assessment of two specific DEI learning outcomes in an introductory chemistry course. The class was offered in the spring semester, 2023, at Front Range Community College in Westminster. The class was a five-credit General Chemistry course and there were 24 students enrolled. It was my first time teaching for this institution. The students were all STEM majors, but only one student identified as potential chemistry major.

To design the two DEI learning outcomes, I examined this list as a guide which is included in Module 1 of the Faculty Institute for Inclusive Teaching (FIIT) at the University of Denver. You can access any of the FIIT modules through Talent@DU.

Challenging historical claims
Invite students to challenge claims presented as objective, neutral, and universal

Design reflective questions about social perspective
Create assignments for students to engage in critical self-exploration about their own social perspective and subjectivity.

Investigate identity development
Help students in developing skills to see themselves as knowledge producers in your discipline, by representing different social identities of accomplished scholars in your content.

Facilitate dialogues on points of view
Begin with an examination of their students' social positions and the relationship between those positions and the knowledge that they have.

Teach students about "positionality"
Introduce students to positionality, which is a significant concept that emerged out of feminist scholarship that describes how essential aspects of identity such as gender, race, social class, age, religion and sexual orientation influence the knowledge that scholars construct (Maher &Tetreault, 2007).

Applying knowledge on positionality to examine scholarly work
Use positionality to help students reveal the importance of identifying the positions and frames of reference from which scholars and writers present their data, interpretations and analyses (Anzaldúa, 1990).

Bring self reflection to your work
Identify your ideological positions as a researcher and how the normative assumptions in your work—an inherent part of feminist and ethnic studies scholarship—contrasts with the empirical paradigm that has dominated Western science (Code, 1991; Harding, 1991).

Design

After reviewing the FIIT DEI learning outcomes, I designed the two DEI learning outcomes listed below, along with the class activities that we engaged in.

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DEI Learning Outcome #1: In this class, we will work to broaden our ideas about what scientists look like and what they do.

Classroom Activities

- Administered accessibility survey before class started, including this prompt: "Please write three words that come to mind when you think about a professional scientist".
- Offered six mini lectures during class to highlight scientists with various identities that have been historically underrepresented in science (examples: transgender, blind, Black, Mexican immigrant, etc.). Each highlight included a story about the scientist's career journey and how they navigated microaggressions, exclusion and being "the only one". Last activity included an introduction of SACNAS, which has chapters at many local 4-year institutions.
- Administered reflective end of semester survey, including this prompt: "Please write three words that come to mind when you think about a professional scientist".

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DEI Learning Outcome #2: In this class, we will critically interrogate the discipline of study (Chemistry) to understand how knowledge is constructed and how this impacts real world application.

Classroom Activities

- Offered six mini lectures during class to highlight global issues that involve chemistry. The lecture included background on the topic and how global teams of scientists interact during research.
- Students were asked to pick a molecule that felt important to them, where it connected with their curiosity, their values or a community issue. They were given a rubric to collect data on the molecule and then tell a story, backed by three scholarly resources.

Assessment of DEI Learning Oucome #1

I used a word cloud to demonstrate the results of the surveys at the beginning of the semester and the end of the semester. In this type of graphic, the word size is determined by the number of times that a word is used. The word cloud on the left shows the results from the accessibility survey that students filled out before the semester started and the word cloud on the right shows the results from the end-of-the-semester survey. The table below shows three examples of individual student responses. Filling out the surveys was optional; I did not assign grades or give participation points.

Ideas about the word clouds:

- "Intelligent" and "curious" were high frequency words on both word clouds. While these words seem to have a positive association with science identity, there is also a possibility that these responses illustrate imposter phenomenon if they don't see many scientists that look like them. I would start the next project by asking a more direct question on a reflective assignment about whether students associate themselves with those words.
- The pre-survey word cloud seems to have more words that make science sound challenging and difficult. I liked seeing words on the post-survey like "fun", "cool", and "bright". In the next iteration of this project, I would ask students to reflect on what feels fun to them about pursuing a career in science.
- It is fascinating that "lab coat" persists, even though I had specific conversations about my appearance and the scientist in the spotlights to shift this stereotype. I am stumped on this one.
- I loved seeing the appearance of "creative" on the post survey as a high frequency item. That's a win!!!

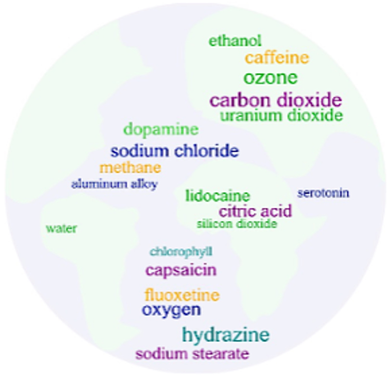
START OF THE SEMESTER	END OF THE SEMESTER
smart, chemicals, good pay	smart, cool, interesting
research, study, tests	inquisite, smart, diverse
glasses, kind of nerdy, evil	fun, creative, passionate

It is helpful to see the difference in responses for individual students. I believe that it pulls out more evidence for the impact of this learning outcome.

- The pre-survey responses are often clinical, superficial and sometimes very negative, without much sense of personal values aligning with this career.
- The post-survey responses are more centered on the "human" aspects of a science career. They illustrate how someone does the work, in terms of their affect instead of the objects that they use/wear.

Assessment of DEI Learning Outcome #2

I used a graphic below on the left to highlight the molecules that the students chose for their Molecule Projects. Four students ended up dropping the class, so there are 20 molecules shown. Each student choose their own unique molecule and needed to convince me of the importance of this study as it related to their personal values or career goals. At the end of the semester, they gave a five-minute presentation to the class with the rubric shown below the graphic. They received 8 points for choosing their molecule and filling out a data sheet during the semester. The student quotes below illustrate some impact of the mini lectures and the project on how they might view chemistry in a different way moving forward.



At the end of the semester, students were also given this prompt:

"*This semester, we worked to critically interrogate the discipline of study (Chemistry) and how this impacts real world application. To do this, we learned about ocean acidification, the use of metric units in all but three countries, mining of cobalt in Africa for electric vehicle batteries and we explored many stories about societal impact in our Molecule projects. What did you learn through these activities?*"

Example responses:

- I learned that there are so many problems in this world that revolve around chemistry. I learned that it takes a team to help these problems get better!
- I learned that there are a lot of ways to solve problems if we take time to understand how a problem affects us.
- I learned how many chemicals and processes that are problematic to us and the environment, but we just ignored because they're not a politically hot topic. There's so much inefficiency and so little work to fix it.
- I learned how essential chemistry is in our everyday lives and what science is necessary to make some changes in our lives and create a sustainable environment for the future.

Data that we have collected:

- Molecular formula
- Picture of molecule
- Types of bonds
- Molar mass
- Empirical formula
- Reaction

What should be included in your poster/blog/website:

24 pts	**Accurate data, listed above, 4 pts each**
18 pts	**Three reliable sources, 6 pts each**
40 pts	**Story about your molecule** will be evaluated by how compelling/interesting the story is
20 pts	**Creative composition of your poster/blog/website** typed (no handwriting), evaluated on design

Next steps for this project

I included some specific ideas to improve assessment in the previous section of this poster. If I were to continue teaching chemistry, I would certainly build out a more comprehensive assessment plan for these DEI learning outcomes. The goal would be to show evidence that students are developing a positive association with a STEM identity and that they can clearly articulate societal impacts.

While the goals of this project seem rooted in a local context (the chemistry classroom), the original intent was to demonstrate the positive impact of designing and assessing DEI learning outcomes ***in any classroom***. As we build DEI learning outcomes for our course, we are likely to frame them through a lens of our own cultural context. In order to learn productively and truly thrive in the classroom, students must bring their identities, lived experiences and prior knowledge to the classroom.

> *"I didn't think about it at the time, but it was happening all over again, an echo of my grandfather's first day at school, when he was order to leave everything – language, culture, family – behind. The professor made me doubt where I came from, what I knew, and claimed that his was the right way to think."*
> **Kimmerer, R. W. (2015). *Braiding Sweetgrass*. Milkweed Editions.**

I was hoping to encourage the adoption of DEI learning outcomes across DU classrooms as concrete step forward towards building inclusive classrooms that encourage students to contribute to knowledge production through reflective classroom activities. These activities would allow the faculty to better understand how to address cultural collisions in the classroom.

Through the Office of Teaching and Learning, DU could begin to gather evidence of implementation and assessment across a wide variety of disciplines and courses. This evidence would be a clear demonstration of DU's commitment to developing inclusive teaching practices that are culturally responsive.

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Take my Survey!

Take a moment to reflect on how you engage your students with your learning outcomes. Some questions that I usually ask people to reflect on:

- Are students aware of the learning outcomes for your course?
- Are any of your learning outcomes focused on issues related to diversity, equity and inclusion?
- Which ones from this poster and project might you use?
- Are you curious about what DEI learning outcomes that other DU faculty are using?

https://tinyurl.com/SFFBECCA