Centering Equity in STEM Teaching: STEM Ideas that Change the World

Ileana Vasu
Holyoke Community College, ivasu@hcc.edu

Follow this and additional works at: https://digitalcommons.calpoly.edu/feministpedagogy

Part of the Engineering Commons, Life Sciences Commons, Physical Sciences and Mathematics Commons, and the Science and Mathematics Education Commons

Recommended Citation
Available at: https://digitalcommons.calpoly.edu/feministpedagogy/vol4/iss2/4

This Original Teaching Activity is brought to you for free and open access by the Journals at DigitalCommons@CalPoly. It has been accepted for inclusion in Feminist Pedagogy by an authorized editor of DigitalCommons@CalPoly. For more information, please contact digitalcommons@calpoly.edu.
Centering Equity in STEM Teaching: STEM Ideas that Change the World

Cover Page Footnote
The author acknowledges her STEM students who have brought this work to life, and her colleagues, professors Vanessa Martinez and Laurel Carpenter for their invaluable contributions to this activity.

This original teaching activity is available in Feminist Pedagogy: https://digitalcommons.calpoly.edu/feministpedagogy/vol4/iss2/4
Title: Centering Equity in STEM Teaching: STEM Ideas that Change the World

Introduction

There is ample evidence of the challenges that marginalized students face in traditional STEM classrooms (McGee, 2016; Mriti, 2019; Uriarte, 2007). Underrepresented STEM students (including women, first generation students, low-income students, and students of color) are often perceived from a "deficit" perspective (i.e., lacking the preparation, learning abilities, and cultural capital necessary to achieve academic success) (Castro, 2014; Weissman et al., 2019). In addition, by favoring practices that empower only the dominant viewpoints or by viewing STEM teaching as race-neutral, our fields perpetuate the status quo (Haynes & Patton, 2019). STEM discoveries exist within culture and context (Mriti, 2019). As such, when diverse students are taught in ways that do not agree with their beliefs, this may further alienate them from these fields.

This article showcases a culturally responsive teaching assignment suitable for freshman and sophomore STEM courses. The assignment is easy to implement and adapt. It offers teachers a nice way to debunk the “banking model” of education (Freire, 1988) and integrate student strengths, backgrounds, interests, and aspirations.

Rationale

Inclusive pedagogy is teaching that embraces the whole student in the learning process and is engaged in a vision of social transformation (Tuitt, 2003). There are many types of inclusive pedagogies including Culturally Relevant Pedagogy or CRP (Ladson-Billings, 1995) and Feminist Pedagogy (Shrewsburry, 1987). Culturally responsive teaching can be defined as “using the cultural characteristics, experiences, and perspectives of ethnically diverse students as conduits for teaching them more effectively” (Gay, 2002, p. 106). Ladson-Billings (2009) claimed CRP “empowers students intellectually, socially, emotionally, and politically using cultural referents to impart knowledge, skills, and attitudes” (p. 20). To her, this is a “pedagogy of opposition not unlike critical pedagogy but specifically committed to collective, not merely individual, empowerment” (Ladson-Billings, 1995, p. 160). Feminist pedagogy rose out of a need to challenge patriarchal dominant practices that often omitted women’s voices and ways of knowing. It advocates for knowledge co-creation, community, empowerment, and reflection (Onuffer & Muno Rojas, 2019).

Cultural barriers may be hard to address in STEM because of the emphasis on so-called objectivity (Mriti, 2019). Inclusive pedagogies help alleviate barriers that students face in STEM and broaden participation (Johnson, 2020; Mriti,
Feminist pedagogy espouses three main tenets: community, empowerment, and leadership (Shrewsbury, 1987) and acknowledges knowledge is situated and reflects the identities of the learners. As STEM educators with a keen eye on equity, we have a duty to step out of the classical view of science as neutral, objective, and individualistic and build learning environments that humanize our disciplines. By creating space for students to be active in creating course content and by reframing the idea of learning as something that our students get to produce and connect to their own lives, we change the traditional teaching paradigm, which is assimilationist in nature and privileges certain types of knowledge over others. Feminist pedagogy and CRP center the community and culture rather than the individual and focus on building critical consciousness and social agency leading social transformation.

I focus this article on a sample assignment that follows the principles of inclusive pedagogy and may be adapted in various contexts. Written for a college freshman or sophomore undergraduate setting of around 30 students, the assignment could be adapted to much larger settings by considering groups. My vision for students is to empower them to succeed in the goals they set for themselves. In selecting and creating assignments, I strive to make them open and generalizable, personal, and through them to focus on building community, empowerment, and leadership.

Explanation

The STEM Ideas That Changed the World assignment (in two parts) aspires to empower students to develop their critical thinking and understand that science is a human endeavor, so they can both celebrate science’s great ideas and also critique, question, and change inequities in current scientific practices. I designed this assignment with two of my teaching partners and used it in introductory STEM courses, and in my own discipline where I re-envisioned it as Math Ideas that Change the World. The assignment allows students to connect their aspirations and interests with authentic and historically accurate facts. The meta-goals associated with the assignment include engaging students to think critically about what it means to be a STEM student, learning about central ideas in STEM, and thinking about who discovered/created these ideas. Along the way they realize that certain people and certain identities have been omitted or erased and that science is not at all neutral, but they, as the generation of tomorrow, can enact change.

When students are assigned this work, they will have already had the opportunity to get to know each other through their STEM narrative stories, community agreements, and other course readings. They have already been exposed to ideas that there are different ways of knowing via short readings and
discussions featuring Indigenous knowledge in juxtaposition with the more platonic, absolute, and so called objective modes of scientific inquiry. These included *Indigenous Knowledge Meets Science to take on climate change* (Ibrahim, 2019) and *Historical Perspectives from the Wigwam* from the Nolumbeka Project (Hogan, 2013), which were contrasted with platonic ideas about reality, the quest for objectivity, and the reductionist nature of science prevalent in traditional views of scientific modes of inquiry.

**Learning Objectives**

- develop awareness about different ideas in STEM that align with their interests and culture
- understand that STEM ideas and modes of thinking are embedded in culture
- understand that there are inequities in STEM, but that we have the power to change things
- develop critical thinking
- develop critical consciousness
- empower students to develop research and communication skills
- create a community of learners who work together
- develop communication skills

The first part of the assignment asks students to explore STEM ideas that change(d) the world and find one they are passionate about to present to the class, along with at least one question about it. While this assignment may be daunting to students new to STEM, we take time to brainstorm some ideas together from GPS, to X-rays, antibiotics, telescope, internet, to scientific theories like evolution or quantum computing. In addition, students get to reflect on why these ideas are important and make some connections to other articles or discussions they are having. Students are also encouraged to see a reference librarian if they need.

Once the first part of the assignment is completed, as a class we select four of these readings to add to our seminar discussions for the semester. Seminar leaders are then chosen in such a way as to allow students who originally selected a reading to facilitate the discussion on that particular reading. I will have modeled appropriate seminar discussion etiquette on two initial articles, and we read a short article on “How to Lead a Seminar” (Harnish, 1995) and add our own modifications to the model. Seminar leaders are tasked with providing some discussion prompts. Every seminar begins with a short five minute paper prompt, so all students can get some thoughts about the reading on paper. This allows everyone to contribute.
Below are the prompts that are given to students for each part of the assignment.

### STEM Ideas That Change(d) The World Part I
In this assignment you will explore ideas that change(d) the world. The assignment provides you with the opportunity to research and think about what changes are relevant to you, your aspirations and careers, and to share these with the rest of us as a community. STEM ideas may often be attributed to one person (although they are much more often the product of many people and many generations, some of whom have been omitted). As you research ideas, be mindful of these patterns.

You will find an article or video that shares a STEM (or your discipline) idea that has changed the world or that you find important or relevant to the world and add your resource to a Google document for our class.

- You will share 2-3 sentences in class about their article, its importance to STEM, and its importance to society and discuss your interest in this topic.
- Then also pose at least one question about the article - for example: “Do you agree that this idea changed the world?” or, “What is the connection between this article and other readings, or ideas you are developing as a result of this course, or other ideas you learned in other courses?”
- As a class we will,
  - come together to listen to each others’ choices and reasons.
  - select some of these readings to read and discuss at the end of the semester.

#### Template:
- Name:
- Article/Video: (with link if possible)
- 2-3 Sentences to share with the class about the article:
- One question about the article:

### STEM Ideas That Change(d) The World Part II: Seminar Discussion.
Students will be divided in groups and asked to lead one seminar discussion during the course semester.

We will follow guidelines for seminars drawn from Harnish, 1995.

To prepare for the seminar,
- Come together and discuss key points or ideas in the article.
- Prepare a list of questions you want the class to address and have them posted on the course’s Moodle page by the seminar date.
Plan to give students five minutes where they can work individually on the questions you posed.

To run the seminar,

- Use the points your colleagues added to bring up discussion points.
- Make sure everyone gets a chance to speak if they wish to and encourage new voices to come to the table.
- Leaving the seminar with more questions than you came with or being somewhat confused and overwhelmed with new ideas is a sign your seminar is working.

Debrief

In the class that follows, I asked students to tell me what they thought about the assignment and what they found out about themselves as learners. I also asked them to write a little journal entry about the experience. They indicated they liked that they have a say in the curriculum and to drive some important discussions around what science is, who gets to do science, and what topics to discuss:

“...I LOVED the student-selected material and presentations. I think our individual personalities and interests have really come out the most when we were able to put the resources together ourselves. These have also led to some of the best conversations in the (...) seminars.”

Assessment

Working in groups students learned to collaborate, lead, and communicate. My role was to model an experienced learner, not to be the focus of attention or the authority (Harnish, 1995). Here is an example of a student response to the first part of the assignment. They discuss Rosalind Franklin’s contribution to the double helix structure of DNA discovery and showcase critical thinking, critical consciousness, and communication skills.

Name: Alana
Article/Video: Rosalind Franklin: The DNA Riddle, King's College 1951-1953
2-3 Sentences to share with the class about the article/video: Rosalind Franklin was an expert physical chemist and X-ray crystallographer. Thanks to her infamous Photo 51 (1952), Rosalind Franklin is now credited as a crucial discoverer of the double helix structure of DNA.
deoxyribonucleic acid (DNA). While Franklin was working on her research James Watson and Francis Crick were also working on discovering the structure of DNA, and ended up seeing Photo 51 without Franklin’s knowing, helping them create their model of the structure of DNA. Franklin’s results were published at the same time as Watson and Crick’s results. However, Watson and Crick, along with another researcher, went on to be awarded the Nobel Prize. Rosalind Franklin passed away in 1958 without knowing Watson and Crick had seen her Photo 51. Only after Franklin died did Crick and Watson give any sort of credit about the discovery to Franklin. Without her Photo 51, they may not have been able to create their renowned model of DNA.

One question about the article/video: When the journal, Nature, published Franklin’s and Watson and Crick’s papers, the latter’s appeared first followed by Franklin’s. If Franklin’s paper had been published first, followed by Watson and Crick’s, do you think Franklin would have gotten the credit for the discovery and Watson and Crick would have been credited with corroborating it?

Ladson-Billings (1995) mentioned three components of CRP: a) long-term academic achievement and not merely end-of-semester or year tests, b) cultural competence, and c) sociopolitical or critical consciousness (i.e., sociopolitical consciousness). These components were clearly evident in the types of questions the students were preparing for our seminar discussions. To illustrate the learning happening, I provide an example of the questions prepared for an article showcasing how gene editing is changing the world.

The conservative argument against Genetically Modified Organisms (GMOs) believes that we should restrict GMOs since we don’t know what side effects this technology could have in the future. A counter to this argument is that GMOs have been on the market for at least two centuries now and that that is long enough to see their benefits and thus long enough to judge their negative effects. (Shafer-Landau 617) The inequity argument against GMOs believes that GMOs are an immoral social practice because they will increase inequity by advancing the rich and leaving behind the poor.

1.) Is there a way for this gene editing technology to decrease inequality or will it only increase it?
2.) Could gene editing technology result in more eugenic practices and how?
3.) CRISPR is known to produce desirable characteristics among individuals; who decides what are those “desirable characteristics?”
4.) Considering all the ethical concerns raised by gene editing, should it be banned or continued to be used?
5.) If gene editing technology becomes a practice in the future, what do you think it could
Further Thoughts

The assignment is part of an ungraded course (Kohn & Bloom, 2020). Ungrading is a broad range of assessment practices that intentionally avoid the (d)evaluative scoring student work and focuses on feedback, student reflection, and student-instructor collaboration to assess, fitting well within a feminist framework (Furgeson, 2023). Students self-assess their growth work in the course several times and meet with me individually to discuss their learning.

Some people may feel that discussing history or ethics in a STEM class may take time away from “real” science topics. To me, this is the real science! From a feminist pedagogy viewpoint, learning is situated. Our STEM students take many STEM classes each academic semester. If we do not make room to discuss issues of access, power, inequity, and marginalization because of the content we have to “cover,” we remain slaves to the patriarchal paradigm we are trying to escape. Worse yet, we do not allow our students the opportunity to be freed from it.
References


