Work in Progress: Science and Engineering for Social Justice: Curriculum Development and Student Impact

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Introduction

In this work-in-progress paper, we describe the design, implementation, and impact of a novel curriculum that explores social justice in the context of science and engineering.

"Science and Engineering for Social Justice" is focused on race, gender, sexuality, and disability. We emphasize what students can do to advocate for and represent diverse peoples, and to promote social justice through science and engineering practice.

In this course, students critically evaluate how cultural and scientific theories of gender/sex, race, disability, and sexuality influence one another. Throughout the course, students are asked to reflect on who gets to be a scientist or engineer, who defines which questions researchers ask and which problems engineers solve, who benefits from these solutions, and what role social justice plays in science and engineering practice.

Throughout the course, we explore these inter-related questions:

1) How do our cultural ideas about race, gender, disability and sexuality influence science/engineering knowledge and practice?
2) On the other hand, how does our science/engineering practice influence our cultural ideas about race, gender, disability and sexuality?
3) How can we use science and engineering to promote social justice for all people?

Here we explore the impact of our new curriculum by analyzing student perceptions of social justice before and after taking the course, and student self-reports on the impact of the course on their ability to identify and approach social justice issues in science and engineering.

We developed "Science and Engineering for Social Justice" after positive student reception of our pilot efforts to develop a curriculum to explore the interplay of diversity and ethics in engineering in the context of a large introductory bioengineering course [1-2]. Whereas these efforts were intended to serve as model curricula to be implemented in an existing course for early engineering students, here we describe the launch of a stand-alone course available to all undergraduates that highlights the roles scientists and engineers can play in promoting social justice.

The first offering of "Science and Engineering for Social Justice" was in Fall 2018 with 31 students from both STEM and non-STEM majors. The is a 5-credit, writing-intensive, discussion-based course. For more information on instructor background, motivation for designing this course, enrollment, curriculum, and course logistics, please see our most recent work [3]. Example curricular materials for will be provided at the conference.

Course Overview
Students explore the impact of science and engineering in society through in-class discussions, assigned readings, and weekly written reflections. Students explore these topics in-depth through in-class debates and an individual analysis of a topic of their choice. In the final team project, students design a science or engineering solution that promotes social justice.

Students are introduced to topics in social justice through lectures, assigned readings, documentaries, discussions of current events, and guest speakers (Table I).

Table I. Overview of Curriculum

Week	Topics and Class Activities
1	Introduction + Classroom expectations What does social justice look like?
2	Implicit Bias Representation: Who Identifies as a Scientist or Engineer? History of Sex/Gender and Sexuality in Science and Engineering
3	History of Disability in Science and Engineering Disability and the Justification of Inequality
4	Introduction to Universal Design Design for People with Disabilities Documentary: “Fixed”
5	Debate: Should we “fix” people or environments? Topic Pitches (individual)
6	History of Race in Science and Engineering Design for Low Resource Settings
7	Scientific Approaches and Engineering Solutions for Contemporary Issues in Social Justice (Guest speakers)
8	Introduction to Bioethics Improving Access to Healthcare Genome Editing, Gene Patenting, and Genetic Data
9	Debate: How should genetic data should be shared?
10	In-class Peer Review Team Project Presentations

The course learning objectives include:

1) Identify how cultural concepts of race, gender, sexuality, and disability have shaped scientific thought and engineering practice (and vice versa) through history.
2) Apply ethical analysis and creative problem solving techniques to design solutions for diverse user groups.
3) Propose approaches to promote social justice in science and engineering practice.
4) Critically evaluate claims about the science of human difference and reflect on how these scientific theories have been used to promote or fight inequality.
5) Evaluate the positive and negative impacts of science, engineering and technology on marginalized groups.
6) Identify how scientists and engineers handle implicit bias during research and design processes.
7) Recognize social justice issues in your community and field of study, and feel empowered to affect change.

For a complete list of learning objectives and other information on curriculum, please see our most recent work [3].

Student Impact

Here we explore the impact of our new curriculum by analyzing student perceptions of social justice before and after taking the course, and student self-reports on the impact of the course on their ability to identify and approach social justice issues in science and engineering.

We evaluated the impact of the course on student perception of social justice in a simple exercise. On the first and last days of class, the students were asked to write down the first five words or phrases that came to mind with the term "social justice." To identify emerging themes, we compared the number of student answers including key themes or specific focus areas from the first to last days of class (Table II).

We found modest increases in the percentage of answers including words representing central themes of the course, including: "equity" or "equality" (4% increase), "accessibility" or "inclusion" (3% increase), "diversity" (2% increase), and "intersectionality" (2% increase).

Table II. Student answers: words related to the term "social justice."

Word in Answer	**% Answers Including Word**		**% Increase**
	First Day of Class	Last Day of Class	
Equality or Equity	10	14	4
Accessibility or Inclusion	10	13	3
Disability	1.4	2.9	1.5
Race	0	2	2
Gender	0	2	2
Diversity	2	4	2
Intersectionality	2	4	2

In addition, we evaluated answers involving specific focus areas of the course: race, gender, sexuality, and disability. We found a small increase in the percentage of answers related to the word "disability" (1.5% increase). On the first day of class, no student included words relating to race, gender, or sexuality. On the last day of class, 3/135 (2%) of student answers contained terms involving race or gender. No answer (0%) included any term related to sexuality. In addition, we found that only 3/31 (10%) students wrote the same answer for at least one of the five words on both days.

At the end of the course, we evaluated the impact of the course through examination of student self-reported data about their perceived ability to identify and approach social justice issues in science and engineering. At the end of the course, students were asked to reflect on what they learned from the course that they can use in the future.

Many students reported gaining confidence in their ability to communicate about social justice and apply their knowledge to future research or design projects. A number of students indicated the course helped them learn to advocate for themselves or other people. Excerpts from student responses include:

> *"Seeing how much I've learned and grown over this quarter, I think the next thing I want to tackle is how to use my knowledge to address these issues in the real world. I think I can be more considerate of social justice issues in future projects [and have an] idea of how to design for disadvantaged communities."*
>
> *"[At the beginning of this class] I wanted to learn how to self-advocate – I don't feel like I have any issues with this now! I must have improved in that respect and that makes me happy."*
>
> *"I'm less apologetic about my interest in issues that directly affect me (feminism and racism/stereotypes…). I shouldn't moderate my interests."*
>
> *"I know a lot more about social justice + language to use when talking about it."*
>
> *"After this class, I feel like I am looking at the world in terms of how accessible it is for different people with different abilities."*
>
> *"From this class I've become more interested specifically in applying technology to social justice issues [while] being mindful of the impact… Today, I [am] more focused on using my power as a woman in CS [computer science] to affect change … I can see how this class really has changed and informed my perspective on what I can personally do… I'm definitely more interested in applying CS to social justice issues."*

The end-of-course student evaluations were very positive. Students reported that they enjoyed the course, learned about new issues, and appreciated the role of social justice in their science and engineering work. Representative excerpts from evaluations include:

> *"I absolutely loved this class and learned so much, and it gave me a lot of awareness and sensitivity to other people"*
>
> *"I learned a lot about the STEM intersection with social justice, which I had never considered before."*
>
> *"I learned a lot about social justice issues I didn't know about before…"*
>
> *"…good balance to my engineering coursework."*
>
> *"This was a topic that I hadn't explored much before and… I now feel more confident tackling topics of social justice."*
>
> *"This was a very stimulating course in that it raised questions I've never had the opportunity to discuss in an academic setting before."*
>
> *"I enjoyed taking a break from the technical aspects of my other engineering courses to take a higher level look at engineering and how it impacts society."*

Conclusion

In this work-in-progress paper, we describe the design, implementation, and impact of a novel curriculum that explores social justice in the context of science and engineering. We examined the impact of the first offering of "Science and Engineering for Social Justice" by analyzing 1) student perceptions of social justice before and after taking the course and 2) student self-reports on the impact of the course on their ability to identify and approach social justice issues in science and engineering. We found that students reported gaining confidence in their ability to communicate about social justice and apply their knowledge to future research or design projects. Student feedback for the course was overwhelmingly positive.

References

1. C. Gunnarsson, C. Birch, and D.G. Hendricks. "Exploring the Interplay of Diversity and Ethics in an Introductory Bioengineering Course", Pacific Northwest Section Conference, American Society for Engineering Education, Seattle WA. (April 2017)
2. C. Birch, C. Gunnarsson, and D.G. Hendricks. "Work in Progress: Exploring the Interplay of Diversity and Ethics in an Introductory Bioengineering Course."

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3. C. Gunnarsson, C. Birch, and D.G. Hendricks “Design and Implementation of an Engineering for Social Justice Curriculum.” Collaborative Network for Engineering and Computing Diversity (CoNECD) Annual Conference, Crystal City, VA. (2019)