LESSON PLAN

Social Sustainability in Local Projects

Title	Social Sustainability in Local Projects
Course	Can be adapted to a variety of Civil and Environmental Engineering courses. This example was used in Civil Engineering Materials. (May fit other engineering disciplines that are associated with site selection for projects, for example chemical plants, electrical power generation.)
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Time duration	Pre-class assignment – about 1 hour In-class discussion – about 1 hour Post-class follow-up – about 30 minutes
Overview	This assignment builds on the topic of sustainability and the social justice oriented credits in the Envision[1] sustainability rating system to get students thinking about the integrated nature of technology and society.
Objectives	Students completing this assignment will be able to: • Explain how the work of engineers (and other STEM professionals) is situated within a social context.

[1] Envision is a sustainability rating system intended for applicability to a wide range of infrastructure projects in sectors such as transportation; power generation and distribution; water, wastewater and stormwater; and communications. Envision was developed and is maintained by the Institute for Sustainable Infrastructure, https://sustainableinfrastructure.org/

- Explain how the Envision credit system works and analyze how a given Envision credit might apply to a particular situation.
- List examples of technical decisions that can have significant social consequences.
- Discuss inequities in past engineering work and tradeoffs in addressing those inequities.
- Reflect on their own viewpoints and how those views might influence their understanding of a situation.

Pedagogical Background

The in-class portion of this activity can be arranged in way similar to what is called a "Jigsaw" activity. In a Jigsaw, students work in 'expert' groups to become knowledgeable with a particular idea or concept, and then 'applied/problem solving' groups are formed with a member from each expert group and asked to work on a problem, each bringing their expertise to the problem.

more information on the Jigsaw approach, visit: https://www.jigsaw.org/index.html

Materials

- Reading on the Socially Situated Nature of STEM (included in this lesson plan)
- Articles related to a current and/or local infrastructure project
- Additional sources about the historical context of the project (if available)
- Envision Sustainable Infrastructure Framework – particularly the credits under the Quality of Life category

Procedures

Pre-Class

Before class, students are assigned to read the article on the socially situated nature of STEM, one or more articles (depending on length) about the engineering project of interest and any other background information, and Envision descriptions for relevant credits (see the example at the end of this lesson plan for links to sample articles and the specific Envision credits used). In the example we have several different articles about the engineering project. When we used this activity we broke students into 3-4 groups having each group read a different article about the project.

Students are asked to respond to a series of questions to reflect on the reading and Envision credits. Here are generalized versions of the questions we used:

1. Briefly explain a) the major problems the ____ project is trying to alleviate, and b) the major problems the new project may create. Drawing from your readings, what can be done to look for a solution that avoids the problems you wrote about in part b?
2. Based on the articles, describe how the ____project meets (addresses) and doesn't meet (address) the Envision credits you read about.
3. What could have been done differently in the _____ project to better meet the Envision credits you read about?
4. Name one other Envision credit that might apply to this case and explain why.
5. During the next class period you will be discussing these articles with students who may have read the same article(s) as you and other students who have read different article(s) about the _____ project. What 3-5 topics do you think will be important to discuss in these groups?
6. How do your personal experiences affect how you read and interpret these articles?
7. What do you think might have been done differently in this project if it was located in an affluent predominately white neighborhood?

In-class Activity Debrief/Discussion

Different instructors might like to use different amounts of structure in leading the class discussion. In one year, we began the class by showing a video about the societal context relevant to the project (instead of having the video as part of the pre-class assignment).

If you like a jigsaw approach, you would first group students into groups of 3-4 with other students who read the same article as they did. Later you would have students re-group to discuss the project with students who read a different article. This approach might work best/ be more compelling if you have a set of articles with very different views on the project. This approach will take some pre-planning in order to get students quickly into groups. Some suggestions for navigating group assignment in large classes include: a) pre-assigning groups in the course learning management system, b) have students pick up a piece of paper with a group number as they enter the classroom, or c) use students' locations in the classroom to organize groups (i.e. students in row 1 turn to face the students in row 2 behind them and so forth).

We have also used a less structured format where students form their own groups. We project the pre-assignment questions on the board as a starting point for student discussions. Instructors can circulate the room and drop in on group conversations.

In both cases we liked the approach of an end-of-class debrief. During the debrief we took the opportunity to remind students the broad range of expertise beyond engineering that is relevant to sustainability in general and social sustainability in particular.

Post-activity reflection

After the activity, students individually fill out a reflection piece, to be submitted one week following the activity. We used the reflection questions common to many P4E assignments, but different questions could be formed to better address topics raised during in-class discussion.

Reflection questions:

- What did you learn from this assignment?
- Think about interacting with other engineering students, especially those who thought differently or had a different approach to the problem from you. How can you apply what you learned to your future interactions?
- Did what you learned in this assignment change your views on how engineers' function or their roles? If so, how?
- What did you like about this assignment?
- What would you change about this assignment to make it more engaging for you?

Possible Extensions to the Activity

There are a range of ways this activity could be extended, including: a) students spending more extensive time learning about the situation and possible solutions; b) creating a larger project that involves students collaborating with agencies involved in the project to address the issues involved; and c) after completing this activity students pick another project/topic of choice and analyze it from multiple perspectives, including applying the Envision principles.

Application to other problems

The jigsaw format for issue discussion can be used in a wide range of situations, as discussed on jigsaw.org. The general structure of this activity could be used to discuss any topic where relevant newspaper articles (or similar) are available.

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An Introduction to the Socially-Situated Nature of STEM

Aramati Casper, Ph.D.

An understanding of social issues may seem far removed from the technical skills needed to design a bridge, describe molecular movement, or study ecosystem function. A physical object like a bridge may be thought of narrowly, as something made of materials and designed for a goal, such as holding a specific load while minimizing costs, but it also makes connections between people.

Practices in STEM fields are rooted in values and assumptions, which may be explicitly stated but often are not. For example, many bridges prioritize vehicle traffic over pedestrian or bicycle traffic, and bridge location influences who and what is impacted during construction and how easily different people can travel. The situated nature of bridges and roads becomes a life-and-death context in situations such as emergency evacuations and severe weather events. In these cases the assumptions made during infrastructure development interact with environmental conditions and differing use patterns. In a severe weather event, such as a snowstorm, road clearing is usually prioritized by starting with main roads; some low-priority housing developments may never be ploughed. However, people who have lower socio-economic status (SES) often work jobs where they still need to report to work in a storm and are more likely to live in neighborhoods that are low-priority for clearing, forcing them to navigate treacherous road conditions and risk accidents. Those with a lower SES are also less likely to own more expensive all-wheel or four-wheel drive cars that can navigate poor conditions better.

The people who design road infrastructure and strategize for snow clearing don't set out to disproportionately harm those with lower SES. However, in all aspects of our lives, including how we think about and do STEM-related activities, we are influenced by our life experiences. Our assumptions (that we may not even be consciously aware we are making) about a situation influence the factors we consider, and if we are not being intentionally inclusive, we may be inadvertently exclusive. It is not possible for the knowledge we possess to exist outside of our experiences; therefore, our knowledge is situated within our experiences, and cannot be neutral or decontextualized. While we can work to step outside our own limited perspective by specifically seeking different perspectives and thinking about the needs of those who are different from ourselves, we still cannot be neutral. While those in STEM fields often claim neutrality, this claimed neutrality erases the context in which knowledge is created and used (1,2). What is usually considered "neutral" in STEM fields is situated in Western ways of thinking and doing science (3). Questions surrounding benefit – how will it help, who needs to be able to use it –as well as questions about potential harm – who will be harmed or excluded, what is the larger environmental and social impact, and who decides what tradeoffs are most important – may be considered from only one or few perspectives.

Due to the culturally embedded nature of everything, including STEM, STEM activities manifest existing biases that benefit those in power (2). Gender, race, ethnicity, abilities, social class, age, language and other factors play an important role in how people have access to resources (4,5). It is vital that we consider the situated nature of science and engineering as we work to address existing social, environmental, and infrastructure challenges and plan for the future. To move toward equitable STEM practices we must not only reflect upon how our identities influence our own perspectives and decision-making, but also create space for collaborative work that includes all the voices of those involved, rather than working from a controlling, top-down strategy (6,7). Addressing inequities in our existing physical and social

structures will not happen if outsiders drop in to fix the problems they see; rather, this collaborative work must shift existing power structures to create space and power for all involved (7,8).

References

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2. Tuana N. Revaluing science: Starting from the practices of women. In: Nelson J, editor. Feminism, Science, and the Philosophy of Science. Dordrecht, The Netherlands: Springer; 1996. p. 17–35.
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Example Application of this Activity to the Central I-70 Project in Denver, Colorado

The Central I-70 Project involves reconstruction of a 10 mile stretch of I-70 in Denver Colorado including adding express lanes in both directions, removing an aging viaduct and dropping a portion of the highway below ground level. This portion of I-70 runs though two low-income neighborhoods in Denver, Globeville and Elyria-Swansea. As part of project design significant consideration was given to how the new construction would affect residents of the neighborhoods. Although some steps were taken to improve outcomes for the impacted communities, resident concerns remained in September 2018 when ground was broken on construction.

Background Material from Colorado Department of Transportation
https://www.codot.gov/projects/i70east/

Background Societal Context
This case talks about the impact of a highway expansion project on a neighborhood that had already been segregated from other parts of Denver and had many residents of color and low socio-economic status. The case offers the opportunity to discuss how so many American cities ended up with segregated and low-income neighborhoods. Here are possible resources about policies such as red-lining and interstate highway construction that have deeply impacted American cities.

https://www.segregatedbydesign.com/

https://www.theatlantic.com/business/archive/2016/03/role-of-highways-in-american-poverty/474282/

https://www.nytimes.com/interactive/2019/08/14/magazine/traffic-atlanta-segregation.html

Karas, D. (2015). Highway to inequity: the disparate impact of the interstate highway system on poor and minority communities in American cities. *New Visions for Public Affairs*, *7*(April), 9-21.

Media Articles about the Impact of the Project
https://www.bloomberg.com/news/articles/2017-01-12/denver-s-i-70-highway-project-inspires-hope-fear
https://www.bloomberg.com/news/articles/2017-01-12/denver-s-i-70-highway-project-inspires-hope-fear
https://www.nytimes.com/2017/02/19/us/denver-interstate-70-expansion.html
https://www.cpr.org/2018/08/03/as-cdot-breaks-ground-on-i-70-rebuild-opposition-vows-to-continue-fight/

Envision Rating System Credits Highlighted in Assignment

This assignment was created using version 3 of the Envision Sustainable Infrastructure Framework. From the Envision Handbook, students were asked to read the introduction to the Quality of Life category and credit QL3.1 Advance Equity and Social Justice.

More information about Jigsaw-type Classroom Assignments

"Jigsaw" type activities were first developed during de-segregation in the United States to start addressing equity issues in newly integrating classrooms. Since then, this type of activity has grown to be used in many different learning environments. For more information see:
Social Psychology Network. (2021). *The Jigsaw Classroom*. https://www.jigsaw.org/index.html