# Teaching the Socially-Situated Nature of Climate Change Science in Technical STEM Courses: A Hurricane Katrina Case Study

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November 21, 2022

**Abstract**

To address climate change, social issues need to be integrated in geoscience-related STEM research and curriculum. However, social issues are often ignored in STEM fields, even though STEM practices are usually implicitly rooted in inequitable values and practices. A previous study showed that some students do not see the relevance of diversity, equity, and inclusion (DEI) activities when they are presented as separate from technical content, and some students argued that social content was irrelevant or inappropriate in a technical STEM course. Some engineering faculty have identified the lack of curriculum as a barrier to integrating the socially embedded nature of STEM into their introductory courses. Therefore, we developed a case that addresses social issues such as race, class, and gender in relationship to the social and environmental characteristics of New Orleans and its built environment. The case shows how marginalized people, who have been historically and systemic discriminated against, suffered the greatest losses under the impacts of climate-change driven Hurricane Katrina. The case uses student-centered learning strategies, is applicable for use in a range of courses, including many geoscience courses, and will be publicly available. In Fall 2019 the case will be taught in two first year undergraduate civil and environmental engineering courses (n [?]120) at a R1 university. Coursework from the case will be analyzed using Qualitative Content Analysis, which distills responses into categories and themes that characterize both commonalities and differences. While we do not yet have results, results will be presented at AGU. Our results will provide insight into the effectiveness of our case study as an intervention as well as challenges and successes in implementation, which may help others implement this or other similar activities. More broadly, our intervention demonstrates one way of integrating content more commonly found in interdisciplinary courses into technical, disciplinary-focuses courses. Our study will provide insight into how students respond when DEI and technical content are interconnected, helping further our ability to prepare students in a range of geoscience-related courses to respond to the challenges of climate change through an equity and justice-oriented lens.

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## Background

STEM practices are socially embedded[1,2,3]

- Historically taught as technical, no social context
- Usually centered on dominant culture's knowledge, practices, and needs
- Disproportionately harms marginalized people
- Inclusive professional identities include technical and social skills and inclusive practices and embrace social responsibility[4]

Lack of curriculum is a barrier to integrate social content into technical curriculum

- Case studies effectively contextualize content[5]
- Contextualized content supports all students, particularly those underrepresented in STEM[4,5]
- Important to embed social context in STEM curriculum for inclusive practices[4]
- Social justice cases integrate professional social responsibility and marginalized situations[6]

**Research Questions:**

- How students' products demonstrate the interconnected nature of engineering and social factors?
- Do students perceive the socially-embedded nature of their work as valuable?

## Course Context

- Introductory Civil Engineering course at a large, R1 university in the Inter-Mountain West of the United States
- Taught by Civil Engineering professor who has taught introductory engineering courses for >20 years.
- 50 minute lecture twice weekly, weekly lab
- Total enrollment: 74 students, 32 consented
  - In class for activity: 62 students, 25 consented
    - 20 first-year, 5 second-year
    - Majors: 1 Engineering Science, 1 Engineering Open Option, 23 Civil Engineering
    - Mean age: 18
    - 36% students of color, 64% white
    - 52% men, 48% women, 0% gender diverse (e.g. transgender, intersex, non-binary).
    - 80% heterosexual, 16% LGB+, 4% prefer not to respond

## Methods

**Intervention**

- Pre-class homework: Read case study, watch a video about integrating local community into problem-solving, and answer reflective questions
- In class activity: group work developing a system model of case study, answer questions using their system model, and develop a system model of different situation of their choice
- Post-class: reflection questions

**Data and Analysis**

- Data: All written responses from the above activities. Prior to this activity we obtained student consent and collected demographic data, as part of our larger study
- Analysis: Qualitative Content Analysis, which distills responses into categories and themes that characterize both similarities and differences – in progress

## Results (in progress)

**96% of students responded positively to the activity. Major themes included social and system-focused skills and concepts.**

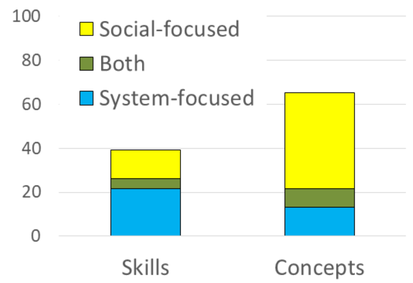



Figure 1: Students reported learning about both social and system skills and concepts. Social skills – group and communication. System skills – building a system model. Social concepts – integration of social and engineering. System concepts – complexity

Student-reported learning (n=25)

- 52% - social context and engineering connectivity

*"Social impacts and systemic oppression play a much larger role in engineering than I first thought."*

- 26% - complexity of systems

*"There are an infinite number of solutions to a problem. It just depends on how you think about it."*

- 26% - system modeling skills,
- 17% - Group-work skills

Transfer to future group work (n=25)

- Group collaboration (46%), broader/social impacts of engineering (33%), and concept mapping (8%), not ready to use new skills (8%), nothing new (8%)

*"It will make me consider who is advantaged by anything I work on."*

Liked about assignment (n=25)

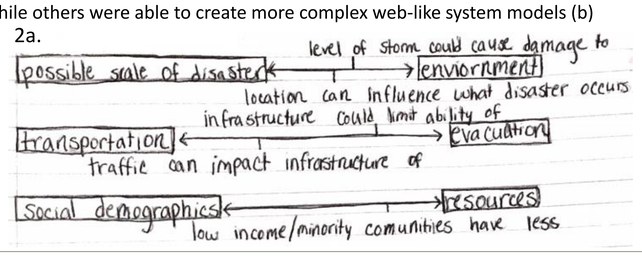
- Innovative (56%), student centered 28(%), social context (28%), real issues (20%), disliked (4%)
- *"I liked the innovative thinking. Not just saying **this** is the solution but what **could** be a solution."*

Group System models (n=4)

- All interconnected social and physical characteristics, only half (2/4) created interconnected webs

Figure 2: Some student groups created simple, disconnected models (a), while others were able to create more complex web-like system models (b)

2a.

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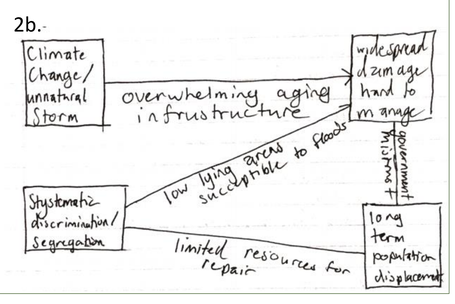


## Discussion

Preliminary results indicate that the case successfully taught students about the importance of the broader social context of engineering and that students valued this social context.

- Student analyzed connections between engineering and social factors in the case study
- More than half of the students reported learning about the connectivity of engineering and social systems

Since contextualized learning supports underrepresented students[5], social-justice rooted cases may serve multiple roles by supporting student persistence, bring real-world material into the classroom, create a space to explicitly discuss the socially-situated nature of STEM, and step beyond the dominant perspectives that often dominate STEM curriculum[6].

Future work

- Implement case across broader context
- Develop and test additional cases
- Evaluate persistence of student learning
- Evaluate student persistence in engineering, since cases can increase underrepresented student persistence in engineering

## Selected References and Acknowledgements

We thank the students enrolled in the course for participating in the study, and the larger P4E (Partnership for Equity) research team for supporting this work. This material is based upon work supported by the National Science Foundation under Grant Nos. 1726268, 1725880 and 1726088. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation

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