# Board 318: Instructor Experiences Integrating Facilitated Socially Engaged Engineering Content in their Courses

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## Introduction

Contemporary engineering work is inherently sociotechnical, requiring engineers to be able to leverage deep technical knowledge as well as account for the social and contextual factors that both shape and are shaped by engineering processes and solutions. There are numerous calls (e.g., [1] - [5]) for engineering education to help students develop what we refer to as socially engaged engineering skills - which relate to conducting engineering work from a holistic and inclusive perspective by gathering, utilizing, and equitably applying rich and diverse contextual information about stakeholders, communities, ethics, the environment, and economic factors. Engineering training, long rooted in technocentric views about the nature of work in the field, has typically stressed the development of technical competencies while underemphasizing socially engaged aspects of engineering work [6] - [8], often touching on such aspects briefly in introductory or capstone courses, if at all [9]. There is increasing interest in helping engineering students develop socially engaged engineering skills, but instructors must be supported in addressing potential challenges in doing so effectively, including time constraints, perceived disconnects between social dimensions and technical course content, and a need for additional tools, resources, and training for integrating socially engaged engineering into their courses [10] - [12].

The Center for Socially Engaged Engineering and Design (C-SED) in the University of Michigan College of Engineering offers a number of resources to help advance the development of socially engaged thinking and skillsets. As one approach for supporting instructors in their integration of socially engaged engineering content in their courses, C-SED partners with instructors to develop and implement a variety of educational sessions, including socially engaged design skills and tools trainings and case study sessions that utilize real-world examples to highlight the impacts of and on engineering work and make visible inequities embedded in engineering processes and structures. These sessions are tailored to the content and learning goals for a course and are offered in a variety of virtual and in person formats. Most commonly, the engineering and design skill trainings and case study sessions are held in person and led by trained graduate student facilitators. While some instructors engage C-SED to implement a single educational session in their course, others partner more closely to integrate C-SED content on a number of topics throughout the semester. Our approach aims to provide a low-barrier way for instructors to integrate socially engaged engineering content closely connected to their existing course focus that does not require them to engage in extensive additional training or effort-intensive independent development of new course materials.

As demand for C-SED's resources increases and C-SED is integrating content in a broader range of courses, insight into instructors' experiences, motivations, and needs is key to ensure the current content and facilitation approaches are effective across a variety of course contexts. The present study describes findings from a survey of instructor partners, including their overall perception of positive contributions of C-SED content to their course, the alignment of seen with regard to other course content, examples of their own strategies for bridging socially engaged engineering content with other engineering topics, preferences for support in the facilitation of socially engaged skills, and other feedback and desired changes or resources going forward, like instructor-facing educational offerings around socially engaged content design. In addition to informing our internal efforts to support current instructor partners and engage in developing new partnerships, our findings provide insight into instructors' priorities and potential strategies that can be leveraged by others engaged in the work of helping engineers develop necessary skills for increasingly sociotechnical engineering work.

**Background**

Engineering encompasses both technical and social dimensions [13] - [15]. Successful engineering solutions not only require technical robustness but also necessitate alignment with stakeholder priorities, contextual factors, and consideration of both local and global consequences [16], [17]. These socially engaged engineering skills are integral for inclusive and comprehensive engineering work and involve the acquisition, application, and equitable utilization of diverse contextual information related to stakeholders, communities, ethics, the environment, and economics.

Despite the critical role of social and contextual consideration in engineering problem solving, skillsets required to engage in social and contextual consideration in appropriate ways are often underdeveloped in traditional engineering education [9], [18]. The insufficient emphasis on socially engaged engineering skills persists despite ABET and national reports underscoring their significance for the future of the engineering profession and the success of engineers' work [19] - [21]. These reports stress the equal importance of socially engaged engineering skills alongside the more conventionally recognized technical engineering skills.

While there is growing recognition about the importance of integrating socially engaged content throughout engineering training, instructors must be provided with the necessary resources to navigate potential barriers to the integration of this new content in their courses. Given the deeply entrenched focus on predominantly technical and mathematical dimensions of engineering work [6], [22], some instructors may not fully understand the importance of or have limited exposure to strategies for making apparent the connections between these technical dimensions and the social and contextual dimensions that influence and are impacted by engineering decisions [10]. Engineering instructors may be reluctant to implement socially

engaged content in their courses on their own [23] and may benefit from external support in the content development and instructional approaches necessary to do so effectively.

In addition to the challenges associated with overcoming long-standing disciplinary norms related to the predominantly technical focus of engineering training, instructors may face additional individual and structural barriers to the adoption of new instructional approaches and course content [11], [12]. The time required to develop new lessons is substantial and faculty reward structures do not always incentivize dedicating time to developing new course content or honing teaching practice [24], [25]. The need for courses to align with particular accreditation criteria such as ABET-defined student learning outcomes and the challenge of finding room in already content-dense curricula are additional considerations that shape instructors' decision making around the adoption of new course content [23], [26]. Understanding and accounting for these barriers is key to the success of any effort to further integrate socially engaged skills and knowledge into engineering courses.

Founded in 2015, the University of Michigan's Center for Socially Engaged Engineering and Design (C-SED) has a distinct focus on reshaping engineering education and practice to better equip future engineers with the skills necessary to address complex, real-world problems. C-SED focuses on educational resources and programs that emphasize the integration of social and contextual elements into engineering work alongside technical considerations. The center defines its approach as 'human(ity) centered,' representing a comprehensive understanding of broad contexts that considers social, cultural, political, economic, and environmental factors of engineering work as well as intentional reflection on how an engineer's identities and cultural contexts shape their approaches to their work. The organization partners with instructors and other community stakeholders to develop a wide variety of socially engaged content that is designed to be adaptable to diverse contexts and instructional needs. C-SED's content and educational strategies are grounded in engineering education and design research and our team regularly seeks feedback and collected data from instructor partners and students to inform our efforts to refine and develop new educational offerings.

C-SED's partnerships with instructional teams and courses primarily include two types of content. The first type of content focuses on the development of socially engaged engineering and design skills, highlighting a human(ity)-centered approach to the design of engineering solutions. A robust collection of sessions on topics addressing different stages of the design process are available to courses and instructor partners. These sessions are typically adapted to the needs of the course and facilitated by trained graduate student facilitators. The educational sessions dive into topics such as the identification and understanding of stakeholders experiences and needs, the definition of engineering challenges considering multiple contextual factors, the ideation of solutions that are responsive to both stakeholders needs and engineering requirements, and the use of prototyping as a mechanism to test ideas, communicate with stakeholders, and try innovative solutions. The goal of these sessions is to provide a framework

to conduct socially engaged engineering design, providing students with opportunities to actively try out a set of tools and practices that will support their design decisions and the generation of engineering solutions.

When C-SED works with an instructor or instructional team to implement engineering and design skills sessions, this partnership can range from a single session in a semester to a comprehensive collaboration to co-define course goals and outcomes and facilitate a series of sessions on different components of the design process. A recent example of this more comprehensive partnership occurred for an upper-level design course with a focus on accessibility. C-SED partnered with the course instructor to make curricular decisions regarding topics, sequence, and learning objectives, and to facilitate a series of eight sessions addressing different aspects of the design process. The course used the socially engaged design process model, developed by C-SED, as a framework for the course design project, focused on developing solutions for accessibility challenges faced by communities with hearing impairments.

C-SED facilitators guided students through eight 80-minute design sessions, covering different phases of the socially engaged design process. These sessions combined the discussion of key design content with structured activities in which students could apply design principles and strategies to their own design projects. Students in this course developed skills to map stakeholders and their relationship to the design challenge, practiced and developed skills to engage with stakeholders and collect data from interviews and observations, learned and applied different strategies to define a design challenge and ideate solutions that are responsive to the needs and experiences of primary stakeholders, and explored different purposes and types of prototypes as they made decisions about solutions to their design challenge. A central thread throughout the eight sessions was the analysis of the role that power, privilege, and identity plays in design decisions, as well as the analysis of students' own positionality in the design project and in the relationships with stakeholders. The C-SED team met regularly with the instructor to discuss feedback and adjust the curricular design as the team projects progressed.

The second type of content C-SED offers is anchored in the Socially Engaged Engineering and Design (SEED) Case Study Initiative, which partners with engineering instructors to develop original case studies highlighting the importance of socially engaged engineering processes and the impacts of engineering work on society. The initiative develops materials for facilitated class sessions, asynchronous modules, and homework assignments, all intentionally aligned with the particular disciplinary focus and course context. The goal of the case studies is to present realistic and immersive microhistorical scenarios that encourage students to engage deeply with the nuances of challenges faced by engineers and consider the equity implications of engineering practice. SEED case studies are based on real-world histories closely connected with various engineering fields, drawing on topics from professional engineering practice, engineering

education, and the history of technology and society. The case studies aim to avoid the "othering" of social content by exposing students to authentic problems and enhancing their sociotechnical thinking skills, such as deep consideration of stakeholders or the complex and sometimes inequitable impacts of engineering decision making.

One recent example of C-SED's partnership with an instructor to implement a SEED case study was a collaboration with a first year engineering class focused on the exploration of research and technologies that support wellness, including wearable sensors that track biometric data. Our team collaborated with the course instructors to bring an eighty-minute session on Wearable Pulse Oximeters, which emerged as an essential monitoring tool during the Covid-19 pandemic. This case study aimed to illustrate the applications and limitations of these types of wellness wearable devices, the conditions in which their measurements create disparate outcomes, and the priorities for healthcare stakeholder groups and how they relate to the adoption of equitable solutions. Through the Pulse Oximeters case study, students were able to explore how oxygen saturation measurements work and consider some of the potential shortcomings of these devices, particularly inaccuracies related to variances in the degree of melanin present in the skin and the potential consequences of these inaccuracies for users with darker skin tones. The session analyzed the ways in which the device's failures relate to the notions of risk and harm, and the implications of these failures in terms of racial health inequities. During the session, students actively worked on building an event sequence of a hypothetical scenario for a user receiving an incorrect measurement, with the purpose of identifying potential harms. This lesson was particularly productive as it informed the work students were doing in their own course projects conducting benchmark and user studies to redesign a biomedical device, taking into consideration the social implications of technical decisions.

**Methods**

In the last several years, C-SED has substantially expanded both our collection of educational sessions and our reach across a wider range of engineering courses within our own institution and into several courses within other universities. The C-SED team has engaged with instructors to identify, tailor, or develop materials and content aligned with the course focus and support implementation of these materials, most often through the use of highly trained graduate student or C-SED staff facilitators. As interest in C-SED's content and implementation support continues to grow, we sought to better understand instructors' experiences with and motivations for engaging with C-SED and the ways our office might best engage with and support instructors in the future. Guided by these goals, we developed a brief questionnaire that we shared with partner instructors who had implemented our content in their courses in the past semester. We draw on this data to explore the following questions:

- RQ1: What do instructors perceive to be valuable for integrating C-SED content into their courses?

- RQ2: What are instructor partners' experiences of working with C-SED on the implementation of socially engaged engineering content
- RQ3: What opportunities exist to support and empower instructors in deepening or broadening inclusion of socially engaged content in engineering?

Our team developed an instructor questionnaire that included questions about partners' motivations for working with C-SED, what the C-SED partnership contributed to their course, the strategies instructors may have employed to situate or build on C-SED content within the rest of their course, the positive and negative aspects of their experiences working with C-SED, and their thoughts on additional socially engaged engineering content that might be useful for C-SED to develop in the future. Our team iterated on the questionnaire and sought feedback from multiple C-SED-affiliated faculty and staff members to determine the focus and framing of the items. Items included 10 Likert-type scale questions and 8 open-ended questions. The full text of the questionnaire is available in Appendix A.

We distributed the questionnaire to all instructors who worked with C-SED to implement our content in their courses in the Fall '23 semester. The questionnaire was shared as a Google Form with recruitment messages sent via personalized emails on the final day of classes in the term, with up to 2 reminder emails sent to instructors who had not yet completed the form. For courses with multiple instructors of record, all instructors were included in our recruitment efforts, even if one instructor was our primary contact in planning the course session(s). Instructors were not compensated for responding to the questionnaire, which we estimated to take less than 15 minutes to complete.

In total, we contacted 40 instructors across 27 courses. Of those, 26 distinct instructors responded from all 27 courses, with two instructors responding for multiple course implementations. These courses in which C-SED content was implemented in the past term included ten 100 level courses, nine 200 or 300 level courses, six 400 level courses, and two graduate courses that included design, professional skill development, and engineering science courses. Twenty of the courses included only a single case study or design skill training, but seven courses included two to four C-SED sessions which included multiple design skill and/or case study topics.

We drew on both the open-ended responses and Likert-type scale items in answering our three research questions outlined above. For the open-ended questions, all authors reviewed the responses to discuss high-level impressions and then the first author engaged in a thematic analysis across all instructor responses to identify key themes as they related to the focus of this paper. All authors then reviewed the framing of these findings to ensure consensus. For the Likert-type scale items, we calculated basic summary statistics and report patterns of responses by percentage of instructors in our findings below.

## Findings

*RQ1: Instructors' perceptions of value in integrating C-SED content*

With regards to what instructors perceived to be valuable for integrating C-SED content into their courses, the thematic analysis of open-ended responses suggested that instructors were motivated to partner with C-SED based on their desire to integrate content that addresses social dimensions of engineering work, like the consideration of stakeholder perspectives in engineering design or the sustainability of design solutions. One instructor expressed this idea saying: "I wanted to introduce students to the importance of considering the social context in which engineering solutions are implemented."

Almost half of the instructors who answered the questionnaire mentioned how previous experiences partnering with C-SED, as well as recommendations from colleagues who experienced valuable partnerships with our center, motivated their continued collaboration. For some instructors, C-SED's educational offerings provided a framework for socially engaged engineering design content that supported their implementation of specific course activities. In some cases this framework even functioned as the foundation for larger engineering design course units, like in the case for an instructor who mentioned: "In many ways, C-SED's collaboration is what made [course name] possible! Many of our course materials were directly created or indirectly inspired by C-SED's".

Two aspects that were valued and frequently mentioned in the open-ended responses were the opportunity to bring into the classroom an "experienced dynamic facilitator," and the alignment instructors saw between the topics of C-SED's educational sessions and the rest of their course content. A quote from one instructor illustrates this idea: "The session helped students think critically about the content they had been reading all semester, and it helped them do it in groups."

A key theme emerging from instructors' responses is the way C-SED materials offer an opportunity and means to intentionally address social dimensions of engineering work that is closely related to the core topics of the course, without the need for instructors to develop specialized expertise in these topics or invest time and effort in developing this new content. As one of the instructors mentioned:

> "Partnering with C-SED meant that we had a new workshop researched and designed for our course by a C-SED consultant, which relieved my co-instructor and I from some of the weight of having to do that extra development on our own."

In some cases, the integration of educational sessions addressing social dimensions and implications of engineering work expanded on a course's existed content, by providing

"additional STEM focused examples" or giving students the opportunity to "see the application of the technical design methods they learn, and see how the application of these methods can be unintentionally biased." In other cases, integration of C-SED content illuminated social dimensions of what an instructor characterized as an otherwise "very technical course" that had not previously highlighted social aspects of engineering.

*RQ2: Instructors' experiences working with C-SED to integrate content*

Instructors broadly described an overall positive experience working with C-SED on the implementation of socially engaged engineering and design content. As shown by instructors' responses to Likert-type scale items, the majority either strongly agreed or agreed with statements highlighting C-SED's positive contributions to their courses, alignment between session content and their course goals, the sessions' role in facilitating deeper understanding from students about social implications of engineering work and interconnectedness of social and technical dimensions of engineering, and the inclusion of engineering skills and knowledge central to students' future work (Table 1).

Table 1. Summary of Survey Responses Part 1 (n=25 participants)

| | Strongly agree | Agree | Neither agree nor disagree | Disagree | Strongly disagree |
|---|---|---|---|---|---|
| Overall, the C-SED session(s) contributed positively to my course | 40% | 60% | 0% | 0% | 0% |
| The C-SED session(s) felt well-aligned with my goals for the course | 56% | 40% | 4% | 0% | 0% |
| C-SED session(s) helped advance students' understanding of the social implications and responsibilities of engineering work | 60% | 36% | 4% | 0% | 0% |
| The C-SED session(s) facilitated students' deeper understanding of the interconnectedness of social and technical dimensions of engineering work | 36% | 60% | 4% | 0% | 0% |

| | | | | | |
|---|---|---|---|---|---|
| The C-SED session(s) touched on engineering skills and knowledge relevant to students' future work | 60% | 36% | 4% | 0% | 0% |

Open-ended responses provided additional insight into instructors' experiences. Some instructors highlighted the quality of the facilitation approach that characterized these educational sessions. As this instructor mentions: "Students were engaged and talkative during the session itself -- the facilitators brought excellent subject knowledge and enthusiasm that were very engaging."

Several instructors described the learning gains they observed in their students and discussed what these educational sessions allowed students to experience, as was the case for one instructor, who shared: "I appreciated the fact that students had the opportunity to put themselves in the position of various stakeholders and get better acquainted with the thorny issues brought up by the case study."

Other instructors described how the C-SED educational sessions allowed students to make connections with social dimensions and implications of engineering work that were not always evident in courses with a technical focus. For instance, one instructor described the sessions facilitated in their class as "supporting students to think more broadly about a topic, especially the societal connections that often are not made explicitly in technical classes."

When asked about the extent to which C-SED sessions helped broaden course content or prepared students to apply this content in their own work, the majority of faculty responded positively, but indicated slightly lower levels of agreement relative to other statements about the experience of partnering with C-SED. These results are summarized in Table 2.

Table 2. Summary of Survey Responses Part 2 (n=25 participants)

| | Strongly agree | Agree | Neither agree nor disagree | Disagree | Strongly disagree |
|---|---|---|---|---|---|
| The C-SED session(s) helped broaden the range of engineering skills and knowledge covered in my course | 52% | 24% | 24% | 0% | 0% |
| The C-SED session(s) prepared my students to apply | 24% | 56% | 20% | 0% | 0% |

| | | | | | |
|---|---|---|---|---|---|
| the content covered in their own work | | | | | |

The analysis of open-ended responses provided some additional context and suggested that the integration of socially engaged engineering and design content and the application of this content to students' own work could be maximized by expanding the connections between the C-SED sessions and the rest of the course content throughout the semester and not only focusing on them at specific moments. For instance, one of the instructors mentioned: "I would love to integrate C-SED content throughout the whole semester and not constrained to the final lecture. It may make the lessons of the final lecture more pertinent to the students as they work on their projects."

As some instructors suggested through open-ended responses, the timing of when the C-SED sessions were scheduled with respect to the rest of the course sequence seemed to play a role in terms of what students could gain from the sessions. Choosing this timing was not always an easy task, since course designs were typically content-dense and instructors felt they did not have a lot of room to move topics around in their course sequences. This challenges was described by an instructor participant:

> "My challenge is often finding the room in the class for additional collaboration with C-SED. Because of the pressures to include different content and outcomes in the class, I do not always have time to integrate as often as I would like."

A couple of instructors shared experiences where the timing of C-SED sessions had unintended results in terms of what students were inspired to do, or did not allow students to connect what they were learning with their own design projects. To this respect, the instructors shared:

> "I think the timing of the brainstorming and lo-fi mockups session backfired a little bit. It encouraged students to start thinking of final solutions too soon, rather than seeing prototyping as a means to better understand their users' needs [...] I think this "miss" was mostly on me and my lack of communication about what I needed and wanted out of the session."

> "For the idea generation topic covered in lecture, it's difficult to integrate this topic into our course because the students don't work on their final project in a team until the last 5 weeks of the semester. [...] It would probably be better to include this visit at a different point, but I'm not sure that we could integrate this session into the progression of topics/assignments earlier in the semester."

Overall, the experiences shared by the instructors suggested a desire to continue partnering with C-SED for the integration of socially engaged engineering and design content, as was expressed in the Likert-type scale item: *I am likely to integrate C-SED content in my course(s) again in the*

*future,* where 84% of the responses strongly agree with the statement. See Table 3 for a summary of responses.

Table 3. Summary of Survey Responses Part 3 (n=25 participants)

| | Strongly agree | Agree | Neither agree nor disagree | Disagree | Strongly disagree |
|---|---|---|---|---|---|
| I am likely to integrate C-SED content in my course(s) again in the future. | 84% | 16% | 0% | 0% | 0% |

*RQ3: Opportunities for broadening or deepening inclusion of socially engaged content in engineering*

Instructors' comments related to opportunities for broadening or deepening the integration of socially engaged engineering and design content suggested a range of current practices and perspectives on what, if anything, could be done differently. Several instructors indicated that they had done "very little" to link C-SED content to other course topics and one expressed, "I should have done more to better integrate it and bring it up multiple times." In contrast, other instructors provided multiple examples of the ways in which they work to make connections between the content C-SED brings into their classrooms and the rest of the course content. Some examples of the ways instructors worked to deepen the inclusion of socially engaged design content included the alignment of the content to course assessment schemes, the use of problem sets that connected with social implications of engineering work, and the intentional attention to socially engaged engineering and design topics in different moments of the course curriculum. The following excerpts shared by instructors in open-ended responses illustrate these ideas:

> "When completing writing assignments reporting on their design ideas (including lab reports), students are required to consider possible social impacts of their designs."
>
> "They [students] had homework problems, exam questions, and reflection modules related to the C-SED content."
>
> "We integrate sociocultural topics into the classroom in many places intentionally, eg example graphics we discuss re: data viz are from data showing who talks most in an engineering design conversation."

Instructors expressed general and consistent desire to continue partnering with C-SED to integrate socially engaged engineering and design content, either using C-SED's facilitators or being supported to facilitate C-SED content on their own. As observed in the responses to Likert-

type scale items, 64% of the responses suggested a desire to facilitate C-SED content if the right support is available. A similar percentage (64%) expressed a preference for having external trained facilitators leading sessions on C-SED related content. These results suggest that in order to continue the integration of socially engaged engineering and design content, instructors should receive consistent support that can alleviate facilitation tasks and address content-related needs. (See Table 4)

Table 4. Summary of Survey Responses Part 4 (n=25 participants)

| | Strongly agree | Agree | Neither agree nor disagree | Disagree | Strongly disagree |
|---|---|---|---|---|---|
| With the right support, I would be interested in covering C-SED content on my own in the future | 32% | 32% | 24% | 0% | 8% |
| I prefer having external facilitators lead course session(s) on the C-SED content in my course | 40% | 24% | 24% | 12% | 0% |

The open-ended responses offered some ideas regarding the ways in which C-SED can continue to support the work of partner instructors. For instance, one instructor suggested the development of "faculty-facing modules" covering aspects related to the design of case studies, as well as modules focused on pedagogical strategies to integrate socially engaged design skills and knowledge into the courses.

**Discussion**

The findings from our instructor questionnaire indicate that current C-SED educational offerings are successful in supporting instructors to integrate socially engaged skills and knowledge into their courses, offering educational sessions that are well-aligned with the rest of the course content, and that illuminate social dimensions of engineering work that are not evident in course designs with a pure technical focus. The C-SED content serves different purposes for different courses, sometimes expanding on existing course content and sometimes providing a unique opportunity for discussion of social dimensions of engineering work in otherwise technically focused courses. Our findings also suggested there are opportunities for future improvement related to identifying the right timing in the course curriculum to integrate this type of content and the frequency in which this content is discussed throughout a course.

Our findings highlight a number of ways in which partnering with C-SED helps to reduce the barriers for instructors' adoption of new socially engaged content into their courses. Consistent with findings from prior work that highlights the hesitation or difficulty for some instructors to independently integrate such content on their own [10], [23], several instructors described C-SED as playing a key role in enabling them to bring in socially engaged topics in their technical courses. Even with the support of C-SED, instructors identified the need to consider additional ways in which they could more effectively discuss and frame C-SED content in the context of the rest of their course. Further, a majority of faculty indicated a preference for continued content and facilitation support rather than teaching socially engaged content entirely independently. Our findings also speak to the more general structural and logistic barriers for faculty adopting new content and instructional approaches. Several instructors noted the ways in which partnering with C-SED helped reduce the time and effort required on their end to revise or develop new course materials, often a key barrier to curricular change [24], [25]. Constraints around the amount of material to cover in a course in limited time is another well-documented barrier (e.g., [23], [26]) that was named by instructors in considering the number and timing of C-SED sessions in their courses, despite their interest in including more socially engaged content. Additional work to develop and implement strategies for more seamless integration of socially engaged and technical content may help address this challenge.

Our results reveal tensions in the successful implementation of C-SED materials within an engineering culture characterized by technocentric priorities, an emphasis on technical content coverage, and a lack of recognition of the social dimensions of engineering work. This finding aligns with existing literature, as described by Cech [22] and Faulkner [6], who highlight the pervasive focus on technical and mathematical aspects within engineering practice. Further, incentives and supports for instructors are minimal with regards to creating space for this type of content. Incorporating socially engaged engineering content is challenging within such a framework, and our findings highlight how content, resources, and instructional delivery provided by C-SED can help overcome some of these hurdles of the engineering culture and the faculty culture of the institution.

The study results have implications for educational initiatives that aim to bring socially engaged engineering and design skills into engineering courses. Establishing close connections between socially engaged engineering and design content and existing technical course material can enhance the success of incorporation. By integrating socially engaged principles directly into technical pieces, instructors can also center social aspects as crucial to engineering practice and success. This approach not only reinforces the relevance of social considerations but also facilitates a more comprehensive understanding of the societal impacts of engineering practices. Particularly for C-SED initiatives, a key implication is that the center continues to focus on the development of processes and systems that prioritize meeting instructors where they are while also providing the necessary support and education to facilitate their independent adoption of the

content. This balanced approach can set up instructors to effectively integrate C-SED principles into their teaching practices at a pace and with the support that aligns with their needs and readiness.

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**Appendix A: Full Text of the Faculty Feedback Questionnaire**

1. What motivated you to work with C-SED to implement content in your course(s) this semester? *(Open response)*

2. Please indicate the extent to which you agree or disagree with the following statements about your experience integrating C-SED content in your course this semester. *(Scale: Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree)*

- Overall, the C-SED session(s) contributed positively to my course
- The C-SED session(s) felt well-aligned with my goals for the course
- The C-SED session(s) helped broaden the range of engineering skills and knowledge covered in my course
- C-SED session(s) helped advance students' understanding of the social implications and responsibilities of engineering work
- The C-SED session(s) facilitated students' deeper understanding of the interconnectedness of social and technical dimensions of engineering work
- The C-SED session(s) prepared my students to apply the content covered in their own work
- The C-SED session(s) touched on engineering skills and knowledge relevant to students' future work
- I am likely to integrate C-SED content in my course(s) again in the future
- With the right support, I would be interested in covering C-SED content on my own in the future
- I prefer having external facilitators lead course session(s) on the C-SED content in my course

3. What, if anything, did partnering with C-SED allow you to do with your course that you may not have otherwise been able to do? *(Open response)*

4. What did you like or think worked well about integrating C-SED content in your course(s) (including feedback about a specific topic/session if you had multiple or comments more broadly about the content, facilitation, planning process, etc.)? *(Open response)*

5. What would you have liked to be different about integrating C-SED content in your course (including feedback about a specific topic/session if you had multiple or comments more broadly about the content, facilitation, planning process, etc.)? *(Open response)*

6. In what ways, if any, do you discuss connections between the C-SED content and the content of the rest of your course? Can you think of any additional resources you might like to support doing so? *(Open response)*

7. In what ways, if any, do you assess students on the skills and knowledge included in C-SED sessions? Can you think of any additional resources you might like to support doing so? *(Open response)*

8. C-SED's current offerings include a wide range of both design skills trainings and socially engaged engineering case studies. What additional topics related to socially engaged engineering or design skills and knowledge, if any, would you find beneficial for C-SED to develop and offer for integration into courses? *(Open response)*

9. Do you have any additional thoughts or feedback related to any aspect of your experiences with C-SED? *(Open response)*