

## **Graduate Student Perceptions of Teaching and Facilitation Skill Development Through a Graduate Facilitator Program**

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# **Graduate Student Perceptions of Teaching and Facilitation Skill Development Through a Graduate Facilitator Program**

## **Introduction**

Contemporary graduate education in STEM has been characterized by persistent calls to enhance graduate programs and experiences with intentional and structured opportunities to develop pedagogical skills that prepare graduate students for future roles in academia (Stowell et al., 2015; Agarwal et al., 2020; Connolly et al., 2018). This form of preparation not only has been conceived as a way of improving graduate student future career opportunities, but also as a way of improving undergraduate STEM education and retention (Winberg et al., 2019). Despite the need to develop teaching skills, graduate programs tend to center research and discipline specific course work (Walker et al., 2008; Connolly et al., 2018). Although opportunities to develop pedagogical skills have expanded in recent years, they vary in format and length, ranging from low engagement events such as one-time discussion panels or workshops, to more intensive engagements like teaching certificates (Connolly et al., 2010). Teaching development opportunities are often limited to one-semester instances where graduate students may take varied roles in a single course and learn on the job by observing teaching practices from faculty members, without consistent structured activities oriented to develop teaching skills (Rivera, 2020). These limited opportunities are constrained to specific topics and learning environments, limiting the repertoire of pedagogical practices graduate students encounter, practice, and learn.

Alongside the need to support the development of pedagogical skills in graduate students, current perspectives on engineering education work highlight its sociotechnical nature. Sociotechnical engineering work requires engineers to be able to leverage their 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., Amadei and Wallace, 2009; UNESCO, 2010) for engineering education to help students develop a more holistic understanding of the field and the skills to practice engineering in sociotechnical ways. This involves applying contextual information about stakeholders, learning from past engineering failures, and broadly considering the possible impacts of their engineering work on society. There is increasing interest in helping engineering students develop these skills, but those in instructional roles must be supported in doing so effectively, including addressing perceived disconnects between social dimensions and technical content and a lack of time to develop and integrate new content into existing courses (Gelles and Lord, 2021; Cheldelin, 2000).

Recognizing these simultaneous needs for graduate students to gain deeper teaching experience and the desire of instructors to be supported in the integration of sociotechnical content into existing curricula, the University of Michigan Center for Socially Engaged Engineering & Design (C-SED) has created a non-academic opportunity called the C-SED Graduate Facilitator Program. Active since 2018, this program equips graduate students with core skills for classroom teaching and offers opportunities to facilitate sessions in the classrooms of partner faculty members. The center's mission is to advance the sociotechnical thinking and skillsets of engineers and designers through evidence-based, transformative learning experiences for students, instructors, and practitioner learners. This includes partnering with around 100 instructors per academic year to integrate content on sociotechnical engineering and design into existing engineering courses.

Following a *just-in-time* training model, graduate facilitators prepare and co-facilitate sociotechnical engineering & design content from the center's library in engineering classrooms and co-curricular environments. Although not a formal academic program, the program aims to develop graduate student self-efficacy and prepare them for future teaching in diverse contexts through intense training and a cohort model that promotes learning with and from others.

This study describes the findings from a survey of current and former graduate student facilitators who had been in the role for a minimum of one year or two academic semesters. The survey explored their perceptions of self-efficacy regarding teaching and facilitation skills, perceived level of confidence in communicating sociotechnical concepts and skills, the influence of the Graduate Facilitator Program on ideas around career possibilities and their perceptions around career readiness of early career faculty. In addition to informing our internal efforts to refine the program to ensure graduate facilitator success in deploying the center's content in engineering classrooms, our findings provide insight into ways that the program has been beneficial to current and past participants in their career pursuits inside and outside of academia.

## **Background**

### **A need for the development of graduate students' pedagogical skills**

Graduate education has frequently been seen as a space for the preparation of future faculty and for the development of teaching and facilitation skills that are able to support the learning of diverse groups of undergraduate students (Cherrstrom et al., 2017; Connolly et al., 2010; Sierra et al., 2015). In the context of STEM education, this form of preparation not only has been conceived as a way of improving graduate student future career opportunities, but also as a way of supporting undergraduate STEM education and retention (Winberg et al., 2019).

Despite the need to develop teaching skills, graduate programs tend to center research and discipline specific course work, leaving the development of teaching skills and the learning of pedagogical practices as a secondary goal. As Walker et al. (2008) suggests, the training of doctoral students has traditionally focused on the development of research methods and practices, and the development of knowledge and skills that are central to their disciplines of study. Graduate students are typically paired with faculty advisors and develop relevant skills in an apprenticeship style model that does not always provide structured opportunities for practice and feedback.

More specifically, with respect to opportunities to develop pedagogical skills, the literature suggests these vary in format, length, and content ranging from low engagement events such as one-time discussion panels or workshops, to more intensive engagements like series of events or programs leading to teaching certificates (Connolly et al., 2010). These learning opportunities are often limited to one-semester instances where graduate students take teaching roles in a single course and learn from unstructured observation of faculty members and mentors. These limited opportunities are constrained to specific topics and learning environments, limiting as well the repertoire of pedagogical practices graduate students encounter, are able to systematically practice, and learn (Rivera, 2020).

### **The Center for Socially Engaged Engineering & Design's Focus**

The Center for Socially Engaged Engineering & Design at the University of Michigan College of Engineering 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. The center's core mission is to advance the sociotechnical thinking and skillsets of engineers and designers by creating evidence-based transformative educational experiences for students, faculty, and practitioner learners. This mission is realized through the design of educational content and programs focused on sociotechnical engineering and design work, the creation of partnerships with instructional teams to integrate this content into engineering courses, the research and assessment of the content and its integration into courses, and the structured support of co-curricular student teams through hybrid learning opportunities and a prototyping lab.

The Center's partnerships with instructional teams and courses primarily include the integration of two types of sociotechnical content into regular course curricula. 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. The goal of this kind of educational session is to provide a framework to conduct socially engaged engineering and 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.

The second type of content the center offers is anchored in a 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 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 reflect on lessons from past engineering failures. The 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 C-SED Graduate Facilitator Program**

The partnerships with instructional teams and courses to bring the different types of sociotechnical educational sessions into engineering classrooms is made possible by a team of graduate facilitators, who are hired on an hourly basis to be part of the center's Graduate Facilitator Program. Created in 2018, this program equips participant graduate students with core skills for classroom facilitation, and offers frequent and diverse opportunities to practice pedagogical skills in the classrooms of partner faculty members. The program develops graduate student self-efficacy and prepares them for teaching roles in diverse contexts through frequent systematic training and a supportive community to learn with and from.

Since its inception in 2018, the C-SED Graduate Facilitator Program has recruited and trained 38 graduate students to facilitate educational sessions in the classrooms of partner faculty members, focusing on sociotechnical engineering and design work. Participant graduate facilitators have a commitment to dedicate between five and ten hours per week to training activities and classroom facilitation. They are paid hourly for their work including the facilitation of sessions, their preparation for facilitated sessions, required meetings, and training.

From the group of 38 graduate students who have joined the program, 20 are master students, and 18 are pursuing doctoral degrees. Although the majority of the graduate students who have joined the program (22) are in various areas of engineering, the program has also welcomed students from social work, public policy, public health, communication and media, environment and sustainability, education, business, art and design, and architecture and urban planning. The cohort of graduate facilitators in the 2024 - 2025 academic year includes nine graduate students.

Graduate facilitators join the program for an average of three semesters of facilitation work, with some of them continuing in the program for up to ten semesters. On average, they facilitate 22 educational sessions in different classrooms and engineering programs. Some of the graduate facilitators with longer tenure in the program had facilitated up to 71 educational sessions and engaged in more than a 100 hours of training.

## **The C-SED Graduate Facilitator Program Training Approach**

Following a *just-in-time* training model, graduate facilitators prepare for and co-facilitate sociotechnical engineering and design content from the center's library in engineering classrooms and co-curricular environments. Different from conventional teaching assistants (TAs), who tend to focus on one single course context and set of topics, the center's graduate facilitators get hands-on experience preparing sessions and teaching a wide range of topics in a diverse set of courses and for different student audiences. Graduate facilitators hold this role for an average of three academic semesters, affording time for systematic practice and skill refinement. The program structure allows graduate facilitators to engage in different aspects of teaching, facilitating content and contributing to the design of educational sessions.

Training activities are built around a cohort model that welcomes new participants with an introductory training session focused on understanding the organization, becoming familiar with the learning objectives and content designed at the center, and the pedagogical approach that characterizes the center's instructional work. Graduate facilitators also engage in biweekly meetings that offer time to reflect and analyze their experiences in classrooms and discuss pedagogical strategies and maneuvers that advance student learning. Ongoing training includes structured planning meetings that prepare facilitators for their instructional work in engineering classrooms. These meetings happen typically a week in advance of a scheduled session, allowing time to process information and prepare for facilitation activities. The assigned graduate facilitators (two co-facilitators) join the center's staff for an hour-long meeting that covers four core components of a facilitation experience: 1) the context of the course in which the session will take place, 2) the goals and components of the educational session, 3) the facilitation approach and pedagogical strategies that will better support student learning, and 4) the logistics associated with the session, like the materials required and the distribution of roles and responsibilities during the session.

These training activities are complemented with the participation in *practice mock sessions*, designed to prototype and iterate on new content, analyze and discuss central aspects of curriculum design, and strategize on facilitation approaches most likely to advance student learning. Graduate facilitators participate in these sessions in a dual role, experiencing the session as if they were students, and analyzing the session from the perspective of the facilitator. These sessions allow for in-depth analysis of instructional practices and development of teaching skills.

## **Methods**

As the C-SED Graduate Facilitator Program continues to grow and bring new graduate students, we sought to better understand the experience of graduate facilitators in four categories of analysis, closely related to pedagogical development and career readiness in areas associated with teaching. Although we understand the relevance of supporting graduate students as they

prepare to enter professional spaces beyond academic environments, like industry, government, and entrepreneurial environments, such areas are situated outside of the scope of our program and the research space of this study. In this study we focus on:

- Perceptions of self-efficacy regarding teaching and facilitation skills
- Perceived level of confidence in communicating sociotechnical concepts and skills
- Influence on ideas around career possibilities
- Perceptions around career readiness of early career faculty.

Guided by this interest, we developed a brief questionnaire that explored participants' perceptions of their development of teaching and facilitation skills, their perceived level of confidence in communicating sociotechnical concepts and skills to different student audiences, the influence that participating in the program might have on their ideas around career possibilities, and their perceptions around career readiness as future faculty.

The questionnaire included 11 Likert-type scale questions and 8 open-ended questions. (The full text of the questionnaire is available in Appendix A.) Our team iterated on the questionnaire and sought feedback from multiple center-affiliated faculty and staff members to determine the focus and framing of the items. We distributed the questionnaire as a Qualtrics Survey with a recruitment message sent via email, and three reminder emails sent to those participants who had not yet completed the survey. The questionnaire was distributed to former and current graduate facilitators who had participated in the program for at least a year (two semesters). This sample group included 25 graduate students (12 master students and 13 doctorate students) and represents 66% of the total number of graduate facilitators (38) who have joined the program since its creation in 2018. Participants were not compensated for completing the survey, which was calculated to take around 15 minutes complete. The response rate was 76%, with 19 out of 25 potential participants completing the survey.

To answer questions about the four categories of analysis outlined before, we drew on both the open-ended responses and Likert-type scale items. For the open-ended questions, the authors did a first review of the responses to discuss high-level impressions. Then the authors engaged in a thematic analysis across all participants' responses to identify key themes as they related to the focus of this paper. We 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 participants in our findings below.

## Findings

### Perceptions of self-efficacy regarding teaching and facilitation skills

With regards to questions focused on perceptions of self-efficacy around teaching and facilitation skills, many mentioned that the experience of facilitating sessions in a diverse set of courses increased their ability to effectively engage with different types of learners in diverse course contexts. Some respondents spoke generally about their experience gaining confidence in teaching and facilitation while others mentioned specific skills. One program participant remarked: “I learned how to be comfortable with silence, how to engage different types of learners and participants.” while another graduate student mentioned that they now “... feel much more confident thinking on my feet and responding to student questions and breaking down complex concepts in ways that are easier for students to understand.” A participant who is in their third year of facilitation with C-SED mentioned “I have so much more confidence in speaking publicly in front of a classroom full of students (I was able to facilitate on stage in a large auditorium for around 100 students, I would've never been able to do this before).”

Graduate facilitators ability to engage with different types of learners and contexts as an indication of growth and development was a theme across many of the open-ended and likert-type questions. 63% of participants strongly agreed and 37% agreed with the statement that *being a graduate facilitator contributed to my confidence teaching and facilitating in different contexts for diverse audiences*. (See Table 1) One participant mentioned: “I think my skills mostly evolved in being able to relate and communicate learning objectives and content to where audiences were in their own learning/design journey” while another stated “I learned ... how to adjust to different classrooms (audience is quiet, audience is going off track, audience doesn't see the value)”.

In addition to having the confidence and skills to engage with different types of audiences, the survey responses indicate that many participants also gained the capacity to adapt their plans to the needs of particular student audiences. One participant mentioned learning to adapt their facilitation approach “on the fly” after realizing that a fixed planned approach may not resonate with a particular group of students, requiring instructional flexibility, while others discussed how over time they gained more comprehensive and nuanced understandings of student needs and used those understandings to adapt their plans and facilitation strategies. One participant shared:

“I learned to identify key learning objectives that were practically achievable within a set amount of time. I learned how to implement active learning strategies, and how to adapt to the flow of these activities during class time. I learned how to assess student learning within the context of different activities. I learned how to tailor content to students' individual goals.”

Over half of the survey respondents indicated that the ability to co-facilitate with other graduate facilitators and learn from peers was a beneficial aspect of the program's design. Some participants illustrate the benefits of learning with and from others as follows:

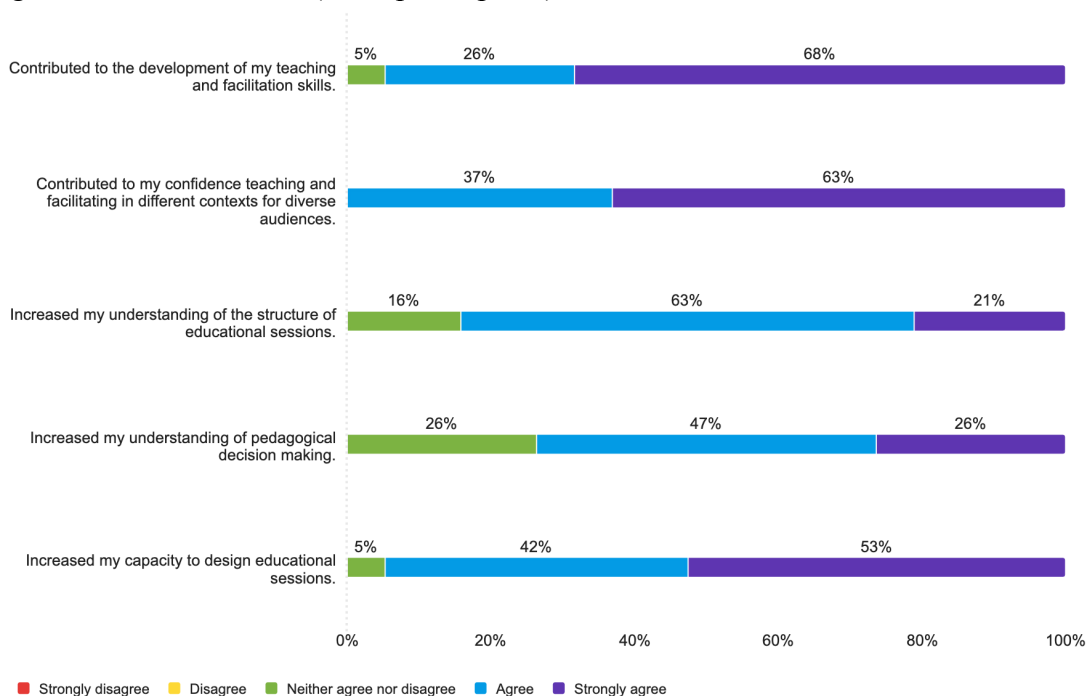
“I do think the conversations between facilitators and staff that we had at meetings or during prep meetings were incredibly helpful for sharing knowledge and developing deeper schools of thought around socially engaged design - what that means, what approach we wanted to have with it, how to communicate it, what challenges are, what it looks like in practice, etc.”

“Practicing facilitation as well as discussing facilitation techniques with the facilitators was helpful. I also think facilitating with other facilitators was good practice in working with others recognizing that all facilitators have slightly different styles.”

Graduate facilitators who have two or more years in the role mentioned growing in their ability to support student learning, not just conveying the details of educational content to an audience, but articulating that content into key ideas within a cohesive story that students can grasp and fully understand:

“At the early stages of my work as a facilitator I focused mostly on content, delivering the facilitation in the way that it was written but now I feel more capable to change the way the content is delivered to students. Over my time, I have also learned to focus on the story that allows students to absorb/understand learning objectives.”

**Table 1:** Responses to likert-type questions that ask about Perceptions of self-efficacy regarding teaching and facilitation skills (n=19 participants)



### **Perceived level of confidence in communicating sociotechnical concepts and skills**

The majority of graduate facilitators surveyed (14 out of 19 survey respondents) described an increased ability to communicate the principles of socially engaged engineering and design as well as general sociotechnical concepts and skills (See Table 2). One participant shared: “My level of confidence increased substantially, since [this] was the main setting where I was able to practice this kind of communication.” Another participant described their capacity to connect social and technical dimensions of engineering and design work as follows:

“I learned a significant amount about how to weave in the "socio" material with the "technical" material in a way that contextualizes engineering within the real world. My level of confidence connecting those dots, making those claims, and prompting students to think about it all improved through being a [...] facilitator.”

Many participants noted that their increased confidence in communication helped them to better engage with engineering students specifically. Since a significant portion of each cohort of graduate facilitators (42%) are not pursuing degrees in engineering fields and/or do not have undergraduate degrees in engineering fields there is often a learning curve around understanding the culture and context of engineering classrooms, especially purely technical courses. One participant shared:

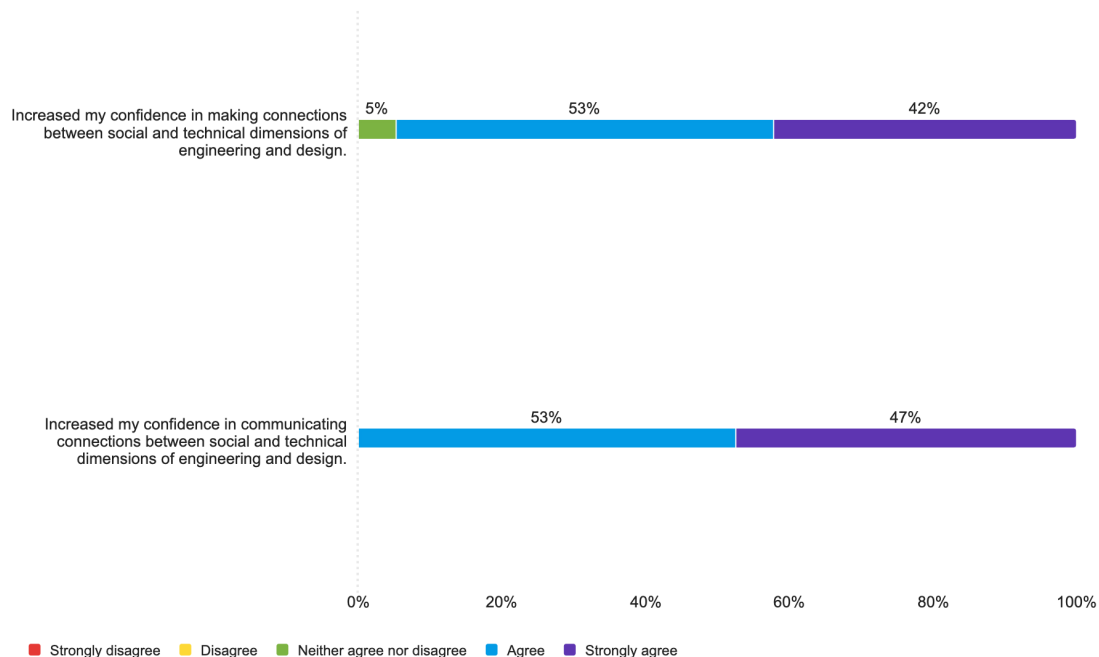
“I don’t come from an engineering background but by the time I finished grad school, I felt I was able to effectively communicate principles from the socially engaged design framework in ways that resonated with students whose education is grounded in the mostly technical engineering world.”

Given this need to become familiar with engineering disciplines, some participants mentioned how this program helped them better understand engineering principles. It is notable that both non-engineering graduate students and engineering graduate students experienced changes in their understanding of engineering as a discipline as a result of their activities as a graduate facilitator. A non-engineering graduate student mentioned: “Prior to [this role], my understanding of engineering was very limited. Through [this role] I became more familiar with engineering terminology and general practices which made me more comfortable applying socially engaged design principles in conversations with students and faculty.” A graduate facilitator pursuing a PhD in Mechanical Engineering indicated that they gained an expanded understanding of the ways in which engineering is practiced and taught: “[Being a facilitator] also opened my eyes to collaborative engineering projects and different examples within industry and education about design and engineering contextual factors and decision making.”

Growing confidence in the ability to communicate sociotechnical concepts and skills was also expressed by some participants who mentioned the benefits of having a repository of examples to lean on in order to confidently express the connections between social and technical elements of engineering and design in discussion formats. A facilitator pursuing a PhD in Mechanical Engineering noted:

“I think having a repertoire of several examples in my back pocket like play pump, deli slicer for pill bottles, soap dispensers not detecting dark skin... helped find tangible ways to talk about these connections. I was already convinced and working on communicating these connections as my whole PhD was about the connections, but facilitating gave me practice in more discussion based communication (as opposed to written).”

**Table 2:** Responses to likert-type questions that ask about level of confidence in understanding & communicating sociotechnical concepts and skills (n=19 participants)



### Influence on ideas around career possibilities

Responses addressing questions around career possibilities point to a variety of ways in which being a facilitator influenced ideas around career aspirations. For half of the participants in the study, being a graduate facilitator helped to solidify and reinforce their existing career aspirations. For others, it solidified their existing aspirations while opening new ideas or potential career pathways. For some participants (4), the experience of being a graduate facilitator prompted what they called a *big shift* in the way they thought about their future careers.

For many current and former graduate facilitators, being a facilitator solidified their existing career ideas and aspirations. One former graduate facilitator remarked, "I don't know if it shifted my ideas about career possibilities but it more so helped me solidify what I wanted to post-degree," highlighting how the experience reinforced their current path rather than altering it.

Another participant expressed, "I came to University of Michigan wanting to pursue faculty roles, this position supported that goal," indicating how the role of a facilitator provided support for their existing faculty ambitions. Similarly, another facilitator noted, "I've always wanted to teach and it gave me confidence that it is a possibility for me in the future."

Some participants acknowledged that being a facilitator reinforced or solidified their existing career aspirations while opening new pathways and ideas. Responses to open ended questions indicate that for some the facilitation experience confirmed their desire to teach in engineering spaces, but expanded their vision of what this might look like to incorporate both technical and social dimensions into their courses. For others, the experience revealed new opportunities for meaningful engagement beyond traditional faculty roles, allowing them to envision a more versatile career.

"I don't think it really impacted my post PhD goals of wanting to focus on teaching in engineering, but it changed what I wanted to teach and how I wanted to show up for my students and be perceived as a faculty member. What types of content I wanted to focus on in engineering, not just technical but the technical and social combined, and really furthered my ideas of design project possibilities on advising and incorporating ethics and sociotechnical knowledge throughout a curriculum and being prepared to do that work in my career."

"I went to grad school with the intent of becoming a professor / I wanted to teach. Facilitating showed me there's ways to have rewarding connections with students outside of a faculty position. I think it was more out of emotional necessity than C-SED specifically, but by the end of my PhD I was convinced I could develop a meaningful career in various areas."

For a smaller number of participants (4), the experience of facilitating at the center prompted a large shift in their career aspirations and actual career pathways. For some, it opened never before considered career pathways in facilitation while for others it meant a shift into a design-related field from another discipline or an experience that synthesized existing interests in an unexpected way. Former facilitators shared:

"It hadn't occurred to me that you could have a career as a facilitator prior to my experience as a graduate facilitator. So it has had a profound impact on my career given that I now work as a facilitator and have launched a company around my design and facilitation skills."

"It was after my first semester of facilitating that I decided to switch my career goals from innovation as a brand manager in the CPG industry to exploring design strategy. I now work at a design agency and am actively implementing a lot of what I learned in C-SED!"

“Before working at C-SED, I was uncertain on how to combine my interests in psychology, engineering, problem solving, and making. C-SED proved that there is a need for curious, empathetic, creative problem solvers who like to facilitate, teach, strategize, and build community. Being a facilitator set the standard for what to look for ... I consider it my first step on my career journey.”

### **Perceptions around career readiness of early career faculty**

Regarding perceptions around career readiness of early career faculty, participants indicate that participation in the program is an experience that has an impact on their career readiness. (See Table 3) Some participants also shared that the skills acquired as a graduate facilitator allowed for a smoother transition and quicker success in a first year faculty role, indicating that the practical teaching experiences gained at the center directly contributed to their preparedness and effectiveness in their first faculty role. Current and former graduate facilitators shared:

“My work at C-SED has shown up most in how it prepared me to teach cornerstone engineering classes (like ENGR100) specifically. We worked with so many ENGR100 sections that I developed a deep understanding of what these classes were supposed to accomplish. At [current institution], I've mainly been teaching the equivalent course, and my [facilitator] experience allowed me to seamlessly step into and iterate on that role.”

“As a current student, being a facilitator has improved my marketability for future professional work. Having previous experience with facilitation shows that I have great communication skills related to public speaking or holding space for difficult discussions, which will always occur in professional workspace. I've had experience with facilitation for different audiences, faculty members, students, and community members. As a graduate facilitator, I teach students about socially engaged engineering design, so I learn about and practice socially engaged engineering design. Critical thinking, being reflexive, engaging with others, and being able to test your assumptions are all practical skills that I teach and simultaneously learn while being a facilitator. Being aware of the social dimensions of design helps me think about potential consequences and who we are leaving out of discussions, which are assets to my future professional work as a scholar, educator, or engineer.”

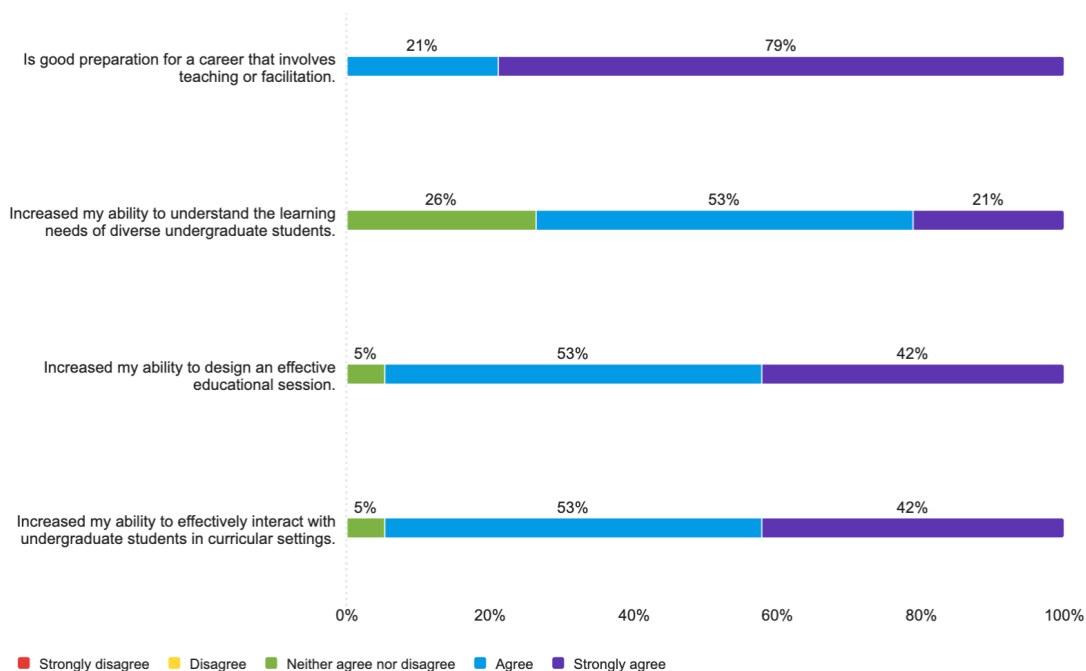
Participants indicated that the role of a graduate facilitator at the center provides valuable preparation for careers by deepening their knowledge of socially engaged design and engineering principles, while also enabling them to translate teaching and facilitation skills beyond the classroom. One facilitator who went on to a career outside of academic noted:

“I think being a facilitator in an academic context better exposes one to what it means to focus on the needs of the customer, as there are not as many business/marketing requirements dictating decisions. For example, in my previous and current position in industry, we work at the intersection of customer needs and business requests, and often

times these are competing with each other. This means there are compromises that have to be made, not always with humans at the center. Working as a facilitator provided me the time and exposure necessary to learn and understand the human centered design process without having to be constrained by the business constraints I experience now. While business constraints are a reality we all have to work within, I think I am better situated to challenge these constraints and attempt to make more human driven decisions.”

Participants understand the Graduate Facilitator Program to be a critical contributor to career readiness, equipping students with essential skills and experiences that significantly enhance their professional trajectories. Program alumni have reported not only gaining a deeper understanding of sociotechnical content but also a smoother transition into faculty positions.

**Table 3:** Responses to likert-type questions that ask about topics related to career readiness of early career faculty (n=19 participants)



## Discussion

The analysis of findings from the graduate facilitator survey suggest that the Center for Socially Engaged Engineering & Design’s Graduate Facilitator Program provides graduate students with opportunities to gain important teaching and facilitation skills and knowledge that are certainly central to faculty roles in academic settings, but that are also transferable to other professional contexts. The structured activities in which graduate facilitators engage allow them to increase

their feelings of confidence in their facilitation skills and their capacity to communicate sociotechnical ideas to diverse audiences of students. The findings suggest that both learning of sociotechnical content and their growing experience in classrooms contributed to their confidence in communicating concepts effectively to diverse student audiences.

Their development of teaching and facilitation skills not only seem to include strategies for in-classroom instruction, but also an understanding of key aspects of the design of educational sessions, and the pedagogical reasoning behind instructional decisions. As might be expected and how it is described in the literature (Rivera, 2020; Connolly et al., 2018) those graduate students who have a more intensive experience in the program, participating in training and facilitation frequently and for longer periods of time, are more likely to experience profound gains in their teaching and facilitation skills, and their capacity to support the learning of diverse groups of students. For graduate facilitators who entered the program with an existing aspiration to teach, this experience confirmed that existing aspiration and encouraged their desire to teach by boosting their overall confidence in pursuing a career in teaching.

The experience of being a facilitator proved to be transformative for many participants, impacting their career trajectories by either reinforcing existing aspirations or prompting new considerations. For several facilitators, the role was instrumental in solidifying their commitment to teaching or academic careers, providing them with confidence and tangible experience to pursue their goals. The program seems to enhance teaching skills to foster a deeper understanding of how technical and social elements can be integrated into engineering education. Additionally, the experience broadened some participants' perspectives, allowing them to explore career possibilities never before considered in both academia and beyond. While the focus of the graduate facilitator program is on the development and refinement of pedagogical skills in classroom contexts, many participants also found tangible benefits to careers outside of academia in roles in industry, government, and entrepreneurial environments.

By providing opportunities to teach diverse student groups in design and engineering settings, the program bolsters the marketability of early career faculty for instructional roles post-graduation. Program alumni have reported not only gaining a deeper understanding of sociotechnical content, but also a smoother transition into faculty positions. Although not the scope of the program, the skills acquired through it—such as effective communication, critical thinking, and an understanding of socially engaged engineering and design—are highly valuable in industry settings.

The findings also suggest that becoming part of a cohort, where graduate facilitators learn with and from others, plays an essential role in the development and evolution of these skills and knowledge. The program's design is such that graduate facilitators collaborate or partner in all the aspects associated with their instructional tasks. Before the facilitation of educational

sessions, they engage in collective planning meetings and discussions to prepare for the sessions. During the sessions themselves, they co-facilitate with a partner and share facilitation roles and responsibilities. After the facilitation, they engage in reflection and analysis of sessions, discussing facilitation strategies, learning needs, and new ways of advancing the learning of the students. These experiences contribute to the creation of a sense of community where graduate facilitators find support and can develop feelings of belonging.

## **Conclusion**

Based on a survey conducted among current and former graduate student facilitators who had been in the role for a minimum of two academic semesters, this study explored participants' perceptions of self-efficacy regarding their teaching and facilitation skills, their perceived level of confidence in communicating sociotechnical concepts and skills, the influence of their experience in the role of graduate facilitator on ideas around career possibilities, and the perceptions around career readiness of early career faculty.

The results of the survey highlight that the experience of facilitating sessions in a diverse set of courses and on different topics increased graduate facilitators ability to effectively engage with different types of learners in diverse course contexts. Many participants also referred to gains in their capacity to adapt the lesson plans to the needs of particular student audiences. These gains were more pronounced for those graduate facilitators who have two or more years in the role. A salient theme in the study was related to the benefits of co-facilitating with other graduate students, having the opportunity to learn with and from peers.

The study also highlighted gains on the ability to communicate the principles of socially engaged engineering and design as well as general sociotechnical concepts and skills. It was notable that both non-engineering graduate students and engineering graduate students experienced changes in their understanding of engineering as a discipline as a result of their activities as a graduate facilitator.

With regards to career aspirations, the study showed a range of experiences. For half of the participants in the study, being a graduate facilitator helped to solidify and reinforce existing career aspirations. For others, it solidified their existing aspirations while opening new ideas or potential career pathways. For some participants, the experience of being a graduate facilitator prompted what they called *a big shift* in the way they thought about their future careers.

Finally, the results of the study indicated that the role of a graduate facilitator provides valuable preparation for careers by deepening graduate facilitator knowledge of socially engaged design and engineering principles, while also enabling them to translate teaching and facilitation skills beyond the classroom.

## **Future work**

As suggested by participants, future work will focus on enhancing the connections between facilitator cohorts as well as on intentionally linking facilitation skills to a variety of career contexts. By developing more structured pathways for current facilitators and alumni to interact, share experiences, and learn from one another, we imagine the possibility of a robust network through which graduate students can identify and leverage their skills in diverse career paths and broaden their professional horizons. Additionally, incorporating mechanisms that allow graduate students to track the development of their skills over time can provide real-time insights into how these skills may be leveraged in various career pathways and enable facilitators to make informed decisions proactively rather than retrospectively.

The overall impact of the Graduate Facilitator Program is evident in the confidence and skills that participants gain. These gains have translated into positive career implications in both teaching and non-teaching roles alike. As participants integrate their skills and abilities into their career planning and execution, they may find themselves better equipped not only to fulfill the responsibilities of early career positions, but also to navigate potential career transitions. Future efforts can build on this success by continuously refining the program to ensure that development of teaching, facilitation, and sociotechnical engineering & design skills are strategically aligned with potential future career opportunities.

## References

- Agarwal, J., Bucks, G., & Murphy, T. J. (2020). A literature synthesis of professional development programs providing pedagogical training to STEM graduate students. In 2020 IEEE Frontiers in Education Conference (FIE) (pp. 1-5). IEEE.  
<https://doi.org/10.1109/FIE44824.2020.9274036>
- Amadei, B. and Wallace, W. A. (2009). Engineering for humanitarian development. IEEE Technology and Society Magazine, vol. 28, no. 4, pp. 6–15. doi: 10.1109/MTS.2009.934940.
- Cheldelin, S. I. (2000). Handling resistance to change. In A. F. Lucas (Ed.), *Leading academic change: Essential roles for departmental chairs* (pp. 55–73). Jossey-Bass.
- Cherrstrom, C. A., Richardson, R., Fowler, D., Autenrieth, R., & Zoran, M. J. (2017). Creating teaching opportunities for STEM future faculty development. *Journal of STEM Teacher Education*, 52(1), 55–69.
- Connolly, M. R., Lee, Y.-G., & Savoy, J. N. (2018). The effects of doctoral teaching development on early-career STEM scholars' college teaching self-efficacy. *CBE—Life Sciences Education*, 17(ar19). <https://doi.org/10.1187/cbe.17-02-0039>
- Connolly, M. R., Savoy, J. N., & Barger, S. S. (2010, April). Future-faculty professional development programs for doctoral students in science, technology, engineering, and mathematics: An exploratory classification scheme [Paper presentation]. American Educational Research Association Annual Meeting, Denver, CO, United States.
- Gelles, L. A. and Lord, S. M. (2021). Pedagogical considerations and challenges for sociotechnical integration within a materials science class. *International Journal of Engineering Education*, vol. 37, no. 5, pp. 1244–1260.
- Love Stowell, S. M., Churchill, A. C., Hund, A. K., Kelsey, K. C., Redmond, M. D., Seiter, S. A., & Barger, N. N. (2015). Transforming graduate training in STEM education. *The Bulletin of the Ecological Society of America*, 96(2), 317–323.
- Rivera, S. (2020). Chapter 2: STEM graduate teaching assistants (GTAs) and the development of STEM pedagogy. In *STEM in science education and S in STEM* (pp. 32-47). Brill.  
[https://doi.org/10.1163/9789004446076\\_003](https://doi.org/10.1163/9789004446076_003)
- UNESCO. (2010). *Engineering: Issues, challenges and opportunities for development*. Paris, France: UNESCO. Retrieved from <http://unesdoc.unesco.org/images/0018/001897/189753e.pdf>

Walker, G. E., Golde, C. M., Jones, L., Bueschel, A. C., & Hutchings, P. (2009). *The formation of scholars: Rethinking doctoral education for the twenty-first century*. John Wiley & Sons.

Winberg, C., Adendorff, H., Bozalek, V., Conana, H., Pallitt, N., Wolff, K., Olsson, T., & Roxå, T. (2019). Learning to teach STEM disciplines in higher education: A critical review of the literature. *Teaching in Higher Education*, 24(8), 930-947.  
<https://doi.org/10.1080/13562517.2018.1517735>

## Appendix 1: Survey

Name

Contact Information

Current Title

Current Institution / Company

Discipline/ Graduate Program/ Undergraduate program

Open Response: Please list any previous experience teaching or facilitating you had before becoming or concurrent with your role as a graduate facilitator at C-SED.

Open response: What motivated you to work with C-SED as a Graduate Facilitator?

Please indicate the extent to which you agree or disagree with the following statements about your experience as a Graduate Facilitator at C-SED.

*Scale: Strongly disagree, disagree, neither agree nor disagree, agree, strongly agree*

[Perceptions of self-efficacy regarding teaching and facilitation skills]

1. Being a C-SED facilitator contributed to the development of my teaching and facilitation skills.
2. Being a C-SED facilitator contributed to my confidence teaching and facilitating in different contexts for diverse audiences.
3. Being a C-SED facilitator increased my understanding of the structure of educational sessions.
4. Being a C-SED facilitator increased my understanding of pedagogical decision making
5. Being a C-SED facilitator increased my capacity to design educational sessions

[Perceived level of confidence in communicating sociotechnical concepts and skills]

6. Being a C-SED facilitator increased my confidence in making connections between social and technical dimensions of engineering and design.
7. Being a C-SED facilitator increased my confidence in communicating connections between social and technical dimensions of engineering and design.

[Perceptions around career readiness of early career faculty]

8. Being a C-SED facilitator is good preparation for a career that involves teaching or facilitation.
9. Being a C-SED facilitator increased my ability to understand the learning needs of diverse undergraduate students.

10. Being a C-SED facilitator increased my ability to design an effective educational session.
11. Being a C-SED facilitator increased my ability to effectively interact with undergraduate students in curricular settings.

Open Response questions:

1. Think back to before you were a graduate facilitator. How did your facilitation and teaching skills evolve as you gained experience as a C-SED facilitator?
2. Think back to before you were a graduate facilitator. How did your level of confidence communicating about social aspects of design and engineering evolve as you gained experience as a C-SED facilitator?
3. In what ways, if any, did your experience as a graduate facilitator at C-SED impact your ideas about career possibilities? Can you share an example of these ideas?
4. What aspects of the graduate facilitator program were most helpful for the development of skills and knowledge?
5. In what ways, if any, have the skills and knowledge you gained and practiced as a C-SED graduate facilitator been useful in your current professional role? Can you share an example? If you are currently still a student, how do you think they might be useful in your future professional work?
6. Do you have any suggestions of aspects of the graduate facilitator program that could be improved in service of career preparation?