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Fostering Effective & Enduring Advocacy in STEM: Exploring the Role of Community Through a Collaborative Autoethnography

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Scenario # 0: A Project is Conceived at ASEE

On a rainy evening in Baltimore, three engineering educators are at the LEES mixer during the 2023 ASEE National Conference and Exhibition. Jacque, then a graduate student at a STEM-focused institution, Meredith, a graduate student at the same institution, and Morgan, a recent graduate, were leaving the event, feeling inspired by the discourse, connections and support they'd found throughout the conference. A theme for them had been feeling the difference between their "normal" STEM setting and their interactions at the conference, which often went beyond the technical to discuss identity, belonging, community, and sociotechnical impacts. They wondered if there was a way to validate and promote these discussions at the intersection of engineering, community, and identity as an integral part of STEM education and practice, when in their experience, they had often remained at the fringe or relegated to courses outside of the technical curriculum.

Background and motivation

Scenario #0 above marks a turning point in the development of a course titled *Effective and Enduring Advocacy: Leading with Compassion in STEM*, catalyzing its transition from an early concept into a fully supported Pilot Course [1]. We now offer the present work, a Collaborative Autoethnography (CAE), which explores the impacts of the course on both students and facilitators.

Development of the Pilot Course and an outline of topics covered are detailed in a previous ASEE publication [1]. The course was built based on a guiding framework for effective and enduring advocacy, which we have defined as *the work we do to transform our world's systems and cultures in ways that we believe will make life, love, and liberation more possible*. A graphical representation of the framework is provided in Appendix A. The Pilot ran as a 6-credit, Pass/Fail, "special topics" course within the School of Engineering & Applied Sciences at The California Institute of Technology (Caltech). It was not a required part of any program, but students did receive official course credit, and some could apply it towards an elective requirement.

Facilitators designed the course to augment the technical, problem-solving mindset integral to engineering curricula and identity with tools grounded in critical consciousness and compassion. The goal was to create a space on campus that recognized the crucial role of community-centered advocacy work in creating positive change both in a STEM-focused institution and the world beyond, while supporting and formally acknowledging students who engage in advocacy work both inside and outside STEM domains.

By explicitly centering work students do in/for their various communities (especially beyond those solely focused on their participation in STEM research or learning), the facilitators hoped to combat feelings of alienation and the loss of motivation that students sometimes experience (and that they had experienced themselves) in STEM programs; these feelings can emerge as students realize their conception of Engineering or other STEM disciplines as focused on helping others is not always aligned with what is taught in traditional curricula [2, 3, 4].

Contributions of the present work

We have chosen to report the outcomes from the first iteration of the Pilot Course through Collaborative Autoethnography (CAE), connecting the individual and shared experiences of both students and facilitators to the broader challenges and opportunities which this course aimed to address. The present research team is therefore comprised of the Pilot Course's organizers and instructors (denoted throughout this work as "facilitators", Jacque, Meredith, Harly and Morgan) as well as several program participants (denoted throughout this work as "students", Kay, Maria, Matthew, Micah, and Nina). We embrace this participatory research approach as a natural extension of the self-reflective, dialogical, and student-centered course structure.

Through dialogue and critical self-reflection both during the Pilot Course and beyond, we have collectively identified the vital role of community in shaping positive and effective course experiences for both students and facilitators. We explore how creating and maintaining a community-supported space for self-reflection, peer-to-peer learning, and vulnerability promoted effective, enduring, and diverse advocacy actions, as well as supported integration of traditionally 'othered' aspects of student identity into a robust conception of engineering and its connections to furthering life, love, and liberation.

Methodology

The Pilot Course was not originally designed to culminate in a Collaborative Autoethnography (CAE) paper; rather, this decision emerged organically as an extension of the course's participatory action framework. CAE aligns with this framework by recognizing students as active contributors to inquiry, rather than passive subjects. It acknowledges their critical insights into research questions, data collection, interpretation, and future directions [5], making it a fitting methodology for a project grounded in critical pedagogy.

CAE offers a distinct alternative to more traditional qualitative research approaches. One option for this study could have been to analyze students' work products as "data" from a researcher/subject perspective. However, CAE challenges this dichotomy by emphasizing shared agency between researchers and participants [6, 7]. Through CAE, students are not merely observed subjects but active co-creators of meaning. Likewise, CAE foregrounds the researcher's subjectivity, emotional engagement, and active role in shaping the research process, rather than positioning researchers as detached, objective observers. This paradigm shift reflects Freire's vision of education as a participatory, dialogic process [8].

As a qualitative methodology, CAE is rooted in ethnography and relies on "thick description" to provide detailed, context-specific analysis [9]. Beyond ethnographic description, however, CAE

places researchers at the center of the inquiry. As both "a process and a product" [10], autoethnography involves cycles of reflection, discussion, and iteration, aligning closely with the Freirean approach that underpins the Pilot Course we discuss in this work. The collaborative dimension of CAE illuminates larger social and cultural dynamics by engaging multiple perspectives [10, 11, 12]. In the case of the Pilot Course, both facilitators and students shared a communal learning experience while maintaining individual subjectivities. This CAE, therefore, documents both our personal and collective learning and growth.

Although this collaboration began after the Pilot Course ended, we remain attentive to the systemic power differentials within our group [11]. At the time of writing, student participants hold a range of statuses and experiences, from undergraduate and graduate students to postdoctoral researchers. Facilitators also vary in their institutional positions, spanning graduate instructors to senior faculty across different universities. Acknowledging and celebrating these diverse perspectives allows us to weave together multiple voices, creating a richer and more nuanced account of our experiences. While prior CAEs have largely involved collaborators with fewer institutional hierarchies separating them [13, 14, 15], our work extends the methodological affordances of CAE by incorporating a broader range of institutional and professional standpoints.

Of course, such diversity can create situations where the professional and personal risks involved in open and vulnerable dialogue are not borne equally by all participants. For example, several program participants are, at the time of writing, still students at the institution where the Pilot Course was offered. Though we do not seek to directly critique this particular institution but rather to explore experiences which stem from the broader culture in STEM academia across institutions, there is potential for misinterpretation of the challenging experiences offered and their relationship to the host institution. To address this risk, we as a research team have taken care to ensure that synthesis across experiences offered as part of this CAE accurately represents the individual views of authors whose voices are included in each element of synthesis, as well as offering complete narrative control over the Vignettes presented by each author in Appendix B. More information about how the CAE was constructed to acknowledge and mitigate power imbalances among authors is provided in the following section.

Though the underlying systems which influence both the act and outcomes of producing this CAE are complex, by embracing these complexities we aim to contribute to the growing use of CAE in engineering education. Our study not only explores an emerging application of this methodology but also demonstrates how CAE can serve as a reflective and participatory tool for documenting educational experiences and power dynamics in collaborative learning environments.

Data collection & preparing our Collaborative Autoethnography

The Pilot Course had three co-facilitators and an external evaluator (Jacque, Morgan, Meredith, and Harly) who are all engaged with the present CAE. Seven students were enrolled in the course: one junior undergraduate, four graduate students, a postdoc, and a faculty member. Of the seven students who completed the course, five elected to participate in the CAE (Kay, Maria, Matthew, Micah, and Nina).

To prepare this work, we first collected and reviewed the artifacts we had co-created during the

Pilot Course: this included discussion forum posts by students and facilitators, artifacts created by students as part of the projects they conducted for the course, final pieces of individual reflection students submitted, and the materials, notes, etc. exchanged by facilitators as the course was created and implemented. Then, we came together as a research team to discuss the most salient aspects of our experiences and identify emerging themes that spanned the experiences of all authors. It was during this process that students reported one of the most salient takeaways was the role of community in shaping their course experience. This community focus resonated with the facilitators, as the course itself would have not come to fruition without their collaboration and co-facilitation.

Once we had collectively selected to center the role of community for the CAE, we proceeded to independently construct a series of "Vignettes", Appendix B, which contain our individual reflections on our backgrounds and motivations for participating in the course, the role of community, and our key takeaways. In our meetings, we also discussed how our individual experiences related to others, the challenges we aimed to address in our Pilot Course, and the 2025 LEES themes (i.e. Truth & Reconciliation, Conflict, Climate Change, and Sociotechnical Integration). These individual vignettes and group discussions form the source material to which we refer frequently throughout the paper.

The writing of the paper itself and the synthesis of ideas that it entailed was largely undertaken by Jacque and Morgan (the lead, co-first authors) with methodological input from Harly. Throughout the writing process, other authors (including both students and facilitators) were actively encouraged to edit, contribute to, and review the work-in-progress to ensure that synthesis accurately reflected the views they had shared in the source materials. We held regular meetings to discuss the work throughout the process, and the lead authors routinely left comments in drafts which "tagged" other authors to draw attention to parts of the draft which explicitly referenced experiences they had shared, or to solicit a particular insight or perspective (e.g., "Does this feel good to you?", "Please elaborate.").

This division of labor was discussed and agreed upon by the research team not to afford narrative control to the lead authors, but to ensure that the lead authors (who, both early in their careers as engineering educators, generally have more to gain professionally from the publication of this paper) took on the majority of the labor. In fact, the affordance of narrative control was a surprising by-product of this decision, and one which the lead authors did not feel entirely comfortable with, especially early in the process. Jacque and Morgan often remarked that the act of synthesizing highly personal experiences of their co-authors was challenging, as they did not wish to overinterpret or misrepresent the experiences of others in service of the narrative. Though this awareness alone does not eliminate the risk that the experiences of authors (particularly student authors) were in fact overinterpreted or misrepresented, seeking active input at multiple points throughout the process helped to ensure that the presented narrative is representative of the experiences of the research team.

Results & reflection

In their vignettes, students and facilitators share a full spectrum of experiences from within the Pilot Course, as well as connections to their STEM education to date. They highlight feelings of

disappointment, rage, and insecurity, along with worries about the relationships between science, engineering, society, and self; however, crucially, our conversations extended far past our fears, to our greatest hopes, and our boldest visions. They deepened reflection, and catalyzed tangible action. Matthew highlights this aspect of the classroom community as he reflects:

> *"I found great joy in talking openly with folks about both my worries about the world and the ways I imagined it could be better. Then seeing how it was made better through collaboration. Finding a group of folks to check in with and work alongside made me feel more confident than ever that social change is possible when we work together and that I can play a part in making that happen."*

This section illustrates individual and collective perspectives on what occurred in our space as it relates to the **past** experiences that we brought to the classroom, the **present** classroom community we created, and our **futures** as effective and enduring advocates.

Past: Diverse backgrounds in a shared environment

At the beginning of the Pilot Course, students generally shared the experiences of completing technical coursework and STEM research at a tech-focused institute, but the classroom was full of differences in terms of the advocacy topics students chose to focus on and the ways they engaged. Some students were early in their advocacy journeys, while others were already taking direct actions within their communities. This variation in experience was expected and celebrated – the intention of facilitators was to remove any barriers to entry for students and set the tone that we, students and facilitators, are all responsible for teaching one another.

Students also had varying motivations for joining the class. Our only undergraduate student, Maria, writes "I was interested in a class that would discuss how to organically introduce my advocacy into my day-to-day profession. I was also interested in how I could make my work with underprivileged Latino students more effective." She was already involved in advocacy as an undergraduate, but the link between her work with underprivileged students and her future career was not yet cultivated through her experiences in a more traditional STEM classroom.

Preparing to enter her final year of graduate school, Nina came with a similar sentiment. She had previous experience engaging in campus leadership but acknowledged that her work had been "rooted in action over reflection" and was curious to explore more "foundational aspects of equity, connection, and purpose" which would ultimately support more effective outcomes. Like Maria, Nina writes "I hoped [the course] would help me explore how my technical work could intersect with meaningful advocacy." Nearly a decade further along in her engineering career than Maria, Nina's research has connections to ocean research and climate change, but she was searching for more direct forms of impact.

We emphasize that the onus to build these connections should not be on students in isolation, as extra work on top of often arduous technical programs. Without actively creating space for critical self-reflection, it may be challenging for students to see how their future careers can meaningfully serve society, while finding belonging in the here and now. For example, our second-year graduate student, Micah, writes "within STEM, I often felt capable… but culturally lost; this imposter phenomenon felt inhibitive at times, even though I felt like I had the academic

fortitude to be welcomed to my home institution." Here Micah highlights that competence in the classroom does not equate to confidence. He identified a dissonance between his technical skills and sense of belonging but had not yet received any tools to resolve this.

Similarly, Morgan, a facilitator, reflects on her time as a graduate student, also having felt "a hefty dose of Impostor Phenomenon," and pointing out that it is "so present at our institution that [she recalled] posters in the hallways which simply read, 'You Belong Here"'. Morgan's feelings resonated with Jacque, another facilitator and the lead instructor for the Pilot Course, while they were graduate students together. Morgan writes that Jacque conceptualized the course after realizing the typical educational experience "can sometimes leave students adrift in the STEM space, losing the connection to communities, values or goals that had anchored us while diving so deeply into technical engineering and science goals".

Our most senior graduate student, Matthew, further illuminates this particular experience and its consequences by describing "a period of depression spurred by the pandemic, the ongoing local visceral reminders of the climate crisis, and an overall mismatch between my day-to-day work and my concerns." He writes that he managed to emerge from this period and started to find "a way back into hope and action" by engaging with solarpunk literature and art, which "provides a positive vision for a better future". With this newfound purpose and energy, Matthew involved himself more with causes and groups that he cares about; however, he had not yet talked openly about his emergent authentic self with his peers or fellow organizers before the Pilot Course. He worried that other folks at Caltech wouldn't share his concerns, might find solarpunk unappealing or unrealizable, or would judge him for being too naïve, impractical, or radical. Overall, he feared that this more authentic version of himself would not fit who a Caltech biology grad student 'should' be.

Our only postdoc, Kay, was already heavily involved in advocacy work. Perhaps the furthest along in her advocacy journey as well as her technical career, Kay had already designed and taught a course at her graduate institution titled *Scientific Responsibility and Citizenship* [16], which "examined case studies in which basic research led to large societal impacts, and how the process and outcomes contained inequities to communities historically excluded from institutional science". Kay had also already identified and engaged with feminism in STEM and the effects of science on society more broadly. She joined the Pilot Course only a few months after arriving at Caltech, hoping to "find a community of like-minded scientists", who value diversity, equity, inclusion, and education as they relate to research and academia.

A common thread connecting most students' motivations for joining the Pilot Course is that they hoped to synthesize different parts of their identities as STEM experts and as engaged advocates. On the first day of class, we discussed the learning outcomes, and each student highlighted one or two that resonated most with their personal goals. Looking back, it is unsurprising that the outcome that stood out the most was:

> *"Students will articulate their scientific and/or engineering identity and how it relates to critical consciousness and their unique potential to shape the world."*

That day, Matthew included a note emphasizing this commitment: "I am excited to confidently say how I want to shape the world and how I can uniquely contribute to it."

We note that while students entered the Pilot Course with diverse backgrounds and advocacy interests, a possible key factor in the successful formation of our course community was the presence of pre-existing social connections. Although we did not all already know one another prior to the Pilot Course, many students and facilitators had encountered one another in various settings; this ranged from one-off meetings at a workshop on campus to existing friendships, shared research groups, previous classes, or advocacy spaces. In her vignette, Meredith notes that these prior relationships offered "a strong position from which to become socially expansive." In particular, in some instances facilitators were more like close peers rather than distant professors, which Meredith highlights as helping to "level the playing field between 'instructor' and student." These existing relationships and leveled hierarchies laid a strong foundation for our classroom community. Considering this along with our diversity in backgrounds and common goals for connection and belonging, we next explore the role that our classroom community had in uplifting both students and instructors on their advocacy journeys.

Present: Our classroom community

Matthew recalls, "From the first day of the course, it was clear that the group of students and teachers were committed to creating a vulnerable and trusting space to talk about our hopes, struggles, and desires in advocating for social change." This leads us to ask: how exactly was that vulnerability and trust achieved, what did it look like, and what were the tangible outcomes? It is challenging to capture the essence of a community through words alone. Additionally, every space, with different students, at a different school, will look unique. To illustrate what our classroom community looked and felt like in the first iteration of the Pilot Course, we provide several scenarios drawn from our collective recollections of our classroom and demonstrate how, through community, we could be fully witnessed by one another, build real change at our university, and see a brighter future for ourselves and the world.

Scenario # 1: Transparency, Openness, Vulnerability on Day 1

From the first day of the course, Jacque, the lead facilitator, modeled transparency by sharing her motivation for creating the course, her experiences as a STEM student, and her personal struggles and dreams. She contextualized the course by explaining how her aspirations for aerospace were rooted in a vision of the field that "helps connect humans to each other and all of us with our universe". However, this was quickly and unexpectedly overshadowed by the field's deep ties to military industries. She talked openly about how she came to grad school with her vision in mind, but that parts of herself that she valued (an authentic connection to self, our universe, and the people who share this planet) were not uplifted in her new space. She described how the field's narrow definitions of success prioritized objectivity, productivity, and confidence while devaluing humanity, ethics, and compassion, which she viewed as equally essential to leadership and innovative progress.

In our first post-course meeting, Matthew reflects on Classroom Scenario #1: "I think it was that moment in the course, which like right from week 1, made me feel confident that it was OK to talk about parts of myself which I had previously not brought to any of my Caltech courses outside of E100 [the Pilot Course]. There's no other course where I would have mentioned the word 'solarpunk', for example. There is no other one where I would have been like, 'hey, one of the most important things which I'm doing right now is I'm at this weird garden at the North End of campus just trying to grow plants for the first time."' Matthew remembers thinking he would focus his work in the course around his most prominent form of advocacy on campus at the time: serving as a bargaining team member of the nascent graduate student and postdoc union. However, after Jacque's Week 1 introduction, he realized what he truly wanted to discuss and collaborate on was his less visible but more personal efforts around creating solarpunk-inspired third spaces on campus that would help people imagine a more sustainable future; moreover, he realized the space felt vulnerable and trusting enough to do so. "[I]t was clear that there was permission to bring those parts [of myself], which aren't always celebrated or prioritized by the Institute, to the space, even if it's not what people knew before [or] thought you were going to be talking about."

Scenario # 2: Building Community through a Restorative "Third Space" Garden

At the midpoint of the Pilot Course, Matthew presented on the idea of a "third space," and Nina talked about a "vigilante garden." Drawing inspiration from each other's efforts and joining forces from there, they grew (both literally and figuratively!) an existing community space on campus, a community garden, to be a re-imagined place where folks could meet to contribute to a common goal, as well as to learn more about food systems and local ecology. Kay also joined this effort, bringing even more friends to garden there and expand the community. Though the course ended, the garden lives on, supported by the community that had developed around it.

The community garden described in Classroom Scenario #2 was one of the more tangible impacts of the Pilot Course. Through connections made during the course, students were empowered to take actions which supported their individual advocacy goals, and work to change the experience they themselves as well as peers at our institution were having. Kay reflected that "[i]t was inspiring to see the passions and actions of my classmates and the ways that they carved out compassionate change-oriented spaces within the confines of a competitive program and institute that doesn't always elevate these values." In creating a restorative third space in the form of a reimagined campus community garden, the impact of the Pilot Course extended beyond the walls of the classroom to begin to affect the experiences of students and other campus community members.

Scenario # 3: Exploring New Paths within STEM

Connections made between facilitators and students supported the weaving together of experiences around careers. During the course, Kay, a postdoc, reached out to Morgan, a recent graduate having just started an Assistant Professor role in the Teaching Stream to discuss career progression. They explored what it could look like to build an academic career around advocacy: Morgan shared her experiences in a teaching stream role and ongoing involvement in projects exploring advocacy work, and Kay shared her experiences taking on these types of projects during her STEM PhD and postdoc. Separately, Maria, an undergraduate student, learned from interactions in the classroom that there are academic careers which focus directly on pedagogy, something she hadn't previously considered.

Further demonstrating the potential for lasting change and highlighting the forward-looking nature of the community we created, Classroom Scenario #3 describes two instances where participants at different phases of their academic journeys connected to inspire each other for their future career trajectories. Maria reflects on this experience: "[p]rior to the class, I had not been considering a career in education. Hearing about my classmates' aspirations regarding professorship and science education was enlightening to say the least." Similarly, finding a community of STEM students who shared similar values and interests outside the lab had been pivotal for Morgan during her graduate studies; she reflects that finding belonging in her STEM discipline during graduate school was closely tied to "find[ing] community through a supportive research group, a departmental student council, a Women in Aerospace group on campus, and later through a collaborative research project which focused specifically on issues of belonging, community and other Diversity, Equity and Inclusion (DEI) facets." Hearing Pilot Course participants' perspectives and commitment to building community-centered advocacy work into their careers reaffirmed Morgan's own decision to do so, while sharing her experiences with participants who were earlier in their careers offered an opportunity to actively create the type of community she had benefited from during her graduate studies.

Scenario # 4: Self Discovery & Being Seen

In his first discussion post during the Pilot Course, Micah described what it might take to advocate "for the coexistence of science and culture within my home state of Hawai'i." He shared that, "[w]hile I often have fears that my viewpoints and eventual experience in science would result in rejection by my own culture, I still have this 'dream vision' where science can operate alongside (and maybe even coupled with) culture." Jacque commented on his post sharing papers by another Native Hawaiian graduate student studying this cultural intersection [17]. Micah read this work and then connected with the author, reporting "I am happy to say that the holistic view on science and culture/society, along with the resistance and struggle to assimilate in the engineering community, are shared experiences". He was relieved to learn he's not alone.

By leveraging our collective network to connect to a wider community and engaging with the literature on pedagogy and epistemological frameworks as described in Classroom Scenario #4, Micah learned that his experiences are worth sharing and studying. He notes that "my previous hardships with STEM (primarily associated with the dialectic relationship with traditional values and the objectives of STEM) were often validated through these discussions and learning that my experiences were worth studying and discussing felt incredibly reassuring." By creating space for discussion on these topics as well as the opportunity to then weave further exploration and reflection directly into the course moving forward (an important aspect of critical pedagogy), our classroom community became a place where this type of questioning and self-reflection was honored. This is a positive step towards resolving the tension Micah felt between his technical competence and feeling "culturally lost" in our STEM-focused institution.

Future: Key outcomes

Overall, the students involved in this CAE report a clearer direction for where their work is headed (advocacy, career, or a combination), a stronger sense of belonging, and increased confidence in their ability to carry out community change.

As mentioned in the previous section, significant career insight was gained during the course. Maria, our only undergraduate student, reports, "From the course, I have learned more about the different kinds of advocacy that my future colleagues are interested in. I also realized from this course that I wanted to pursue professorship, specifically in a lecturer or undergraduate advisor role, so as to work with underprivileged minority students in higher education to help with STEM retention." While Kay is still immersed in her postdoctoral role, she also gained a better sense of how to integrate her advocacy into her future career opportunities, reflecting that "Being a part of this course in the time when I was trying to decide what type of career I wanted to pursue helped me envision ways that I could continue to make advocacy part of my career as I move forward, and the ways that my role can evolve." She had worried that the pressures and commitments of an R1 career path would run counter to her advocacy goals, but discussions with Morgan and other course participants gave her more confidence that she would be able to continue her advocacy work in a career in academia, and that a role as a professor would enable her to support students in ways currently inaccessible to her.

Micah reflects, "I feel that I am better armed with the tools necessary to continue with my advocacy journey. While there are certain challenges with my advocacy path (namely with respect to the universality, or lack thereof, of the values present in my home community and STEM experiences), I feel that I can give and receive feedback and guide my peers in a balanced way; while my experience in the course placed more emphasis on reflecting upon my previous experiences, the course staff gave me the knowledge and confidence needed to distill my reflection into action. I really loved dedicating two hours a week discussing our journeys, thoughts, and challenges with friends, and these discussions/ activities really catalyzed my sense of purpose within my graduate school experience." Similarly, Matthew mentions his key takeaways also involved community action and greater confidence in his advocacy work: "I came out of this class with a much clearer idea of the roles I want to play to bring about social change and the confidence to share my advocacy hopes with others in order to work together in making them a reality."

Another takeaway centers the energizing benefits of a positive vision for the future, for both facilitators and students, as highlighted by Morgan and Nina. Morgan reflects, "having a positive vision (imagining not what I wish were gone, but what I wish were present) to build towards in the face of hard problems like addressing climate change, or creating institutional change in large organizations such as universities has already begun to enhance my motivation to continue my advocacy work." For Nina, while she is still exploring "unexpected and new directions" for her advocacy work, she identified "climate optimism" as an unintentional but beautiful learning outcome. Reflecting on our community and her takeaways, she notes, "[t]heir experiences, perspectives, and openness challenged me to reevaluate long-held assumptions and encouraged me to approach advocacy with renewed clarity and optimism."

Conclusions: Impacts of the Pilot Course

Sociotechnical thinking, identity development, and building confidence

At its core, the Pilot Course discussed throughout this work was meant to create a curricular space where social and community-centered concerns held by students could be validated, discussed, and approached using tools that are less commonly taught in engineering curricula. Facilitators captured this aspect of the course through its learning outcomes, in particular: "By participating, students will articulate their scientific and/or engineering identity and how it relates to critical consciousness and their unique potential to shape the world."

While the concept of "sociotechnical thinking" was not explicitly taught in the course, incorporating the above learning outcome promotes a view of scientific and/or engineering identity which is inherently sociotechnical. It invites students to see both technical competencies and how these competencies have the potential to shape the world as integral elements of identity. It also invites students to consider the relationships between their whole selves and their concept of science and/or engineering, and how their experiences or those of their communities shape their practice.

These ideas around identity were of interest to students in the Pilot Course beginning from the first class. Students and facilitators came into this space with a diversity of experiences and confidence levels surrounding their identities as both scientists/engineers and as advocates. Throughout the course, many participants experienced growth in their confidence and self-actualization as engineers and scientists. For example, one student came into the course feeling competent but not confident as a STEM professional, but left feeling he had the tools he needed to continue both his advocacy work and to build a sense of purpose in his academic career.

This Pilot Course is uniquely positioned to support students on such intellectual and emotional journeys. By explicitly creating a community of learners, each with their own positionality and relationship to their STEM identity, students supported each other in learning more about these parts of themselves. When given this opportunity, students played many different roles in our classroom "ecosystem," as discussed by Iyer [18]. For example, Matthew acted as a Guide, sharing resources for self-study and reflection with both students and instructors. In some sense, each student was tasked with taking on the role of Visionary, to conceptualize the world they want to create through their advocacy work. The use of critical pedagogy helped students grow their

confidence in critically examining their relationship with STEM identity through dialogue and reflection in community with other learners. Facilitators suspect that there are close ties between our collective experiences and Perry's Model for Ethical and Intellectual Development, which would describe the action of examining ones' beliefs about identity (and who is granted authority over them) as critical for intellectual development in this area [19]. Further exploration of this connection is left for future works.

Foundations for social impact

Although the actual advocacy topics that students chose to pursue are not the focus of the current paper, it is worth mentioning that through the creation of a space that promoted authentic participation and the formation of a supportive community of advocates, significant impacts (both inward and outward) were realized. For example, several students worked together to evolve a community garden space on campus and educate peers and community members about the local food system in Los Angeles and beyond; another student gained connections to a network of peers sharing a heritage and identity, while simultaneously finding support among diverse peers who shared feelings of alienation from traditional STEM teaching and culture. A third student found purpose and guidance for the next chapter of their STEM journey through open discussion with other students and facilitators.

Given the space and opportunity to share their worries, goals, and dreams for a new future, students did. In an open-ended course ostensibly about Engineering Leadership, together students and facilitators explored themes related to Truth and Reconciliation, restorative justice and conflict resolution, environmental justice and food security, and so many other critical topics where engineers past, present, and future have an important role to play. By engaging with these topics on a personal, human level in community with motivated peers, we have created an enduring web of advocates who feel more confident in integrating their technical expertise with critical social consciousness to continue to make an impact.

Creating a "Community of Practice": Advocates on a tech-focused college campus

At the conclusion of the Pilot Course, we discovered that we had essentially created a Community of Practice (CoP) around effective and enduring advocacy. Meredith and Matthew had both had leadership roles in a pre-established CoP at Caltech, and their experience was integral in noticing and better understanding this unintended but significant outcome. Meredith explains this connection in her vignette: "There are three key aspects of a community of practice in the literature. First, a community of practice must have a specific domain. There must be a shared interest among members [...] Second, there must be a true community. Members must feel connected to the group and feel like their contributions to the group are valued equally [...] Last, the community must practice. The members must use the shared resources and knowledge as practitioners, weaving community wisdom into their own unique practice [20, 21]." She further illuminates, "We had inadvertently created and sustained a community of practice through our course, including all three key aspects. The topic of the course itself fulfilled the first aspect (domain) and the activities throughout the course helped to fulfil the last aspect (practice), but the aspect that I think was crucial to the community of practice developing without our explicit cultivation was the community." She concludes by remarking that in future iterations of the

course, where preexisting social connections and/or experience with communities of practice are not present, "intentional cultivation of a community of practice may need to be prioritized". Fortunately, there is a wealth of literature on this topic that we can explore as we continue this project, both the course development and the research components [20, 21, 22, 23].

Enduring work

The 'enduring' dimension of facilitators' ongoing work is two-fold: first and foremost, facilitators hoped to help students build advocacy practices that support them in sustaining their efforts beyond the Pilot Course, and second, they aimed to create space in the curriculum for advocacy work that creates a lasting, meaningful impact. The facilitators plan to conduct a longitudinal study that will provide valuable insight into the lasting impact of this course on both the advocacy it fosters and the advocates it nurtures. Through such a study, facilitators aim to embody the very principles of effective and enduring advocacy that the course seeks to instill, in creating inquiry which is itself enduring.

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Appendix A: A framework for effective and enduring advocacy

This was the guiding framework for the Pilot Course, which was originally presented as a poster in 2024 at the ASEE Annual Conference & Exposition [1]. For more detail on the creation of the framework, see Jacque's vignette in Appendix B.

1. **Find your focus**: Encourage students to let go of perfectionism and overachievement to focus their attention on a single challenge that matters most to them.
2. **See your strengths**: Guide students in identifying their unique strengths and how to leverage them for their advocacy, helping to make their efforts more impactful and less prone to burnout. Employ the "Social Change Ecosystem Map" developed by Iyer, which outlines ten distinct, non-hierarchical, interconnected roles [18].
3. **Balance reflection and action**: Emphasize the importance of maintaining a "praxis" as discussed by Paulo Freire [8]. Reflection promotes learning about all aspects of our focus and our strengths to inform our perspectives and paths forward and assessing our impact. Action is about applying our knowledge, strength, and passion to enact change within our world.
4. **Feel joy and love along the way**: Recognize that there is not really an end goal to building a better world and encourage students to find joy in the building itself. Promote joy by celebrating personal growth, the connections formed in teams, and in serving our communities and planet.

Appendix B: Vignettes

Vignettes were individually prepared by each member of the research team after the conclusion of the Pilot Course, to synthesize their experiences leading up to and throughout the quarter. To guide the vignette writing process, facilitators brainstormed, with student input, some general questions to get students started. The provided structure centered the following questions (quoted from a discussion with both students and facilitators present):

- Why did you join the class, what did you come in with?
- How did the community influence your journey in the course?
- What are your takeaways?

The emphasis on community came after an initial meeting in which students highlighted this as the most meaningful aspect of the course. These questions were not meant to limit what students wrote about but rather to provide some guidance to help them begin.

In their vignettes, facilitators reflect more generally on what prompted them to participate in the development of this course, and what it meant from their perspectives.

Jacque

I created the advocacy framework implemented in this course and led the overall course development. At the time of running the pilot, I was in my final year of my aerospace engineering PhD at Caltech in Pasadena, CA. Prior to that, I completed a Mechanical engineering BS at Drexel in Philadelphia PA, my home city. Now, while writing this CAE, I am an adjunct professor back in the Philly area. Considering how much I struggled through my graduate degree, it is surprising to me that I'm not only now teaching technical material, but how much I enjoy it. It seems that my struggles have shaped me into an effective and empathetic engineering professor, and ultimately, have led me to developing this framework and course.

I attribute some of my struggles to being a first-generation college student, sprinkled with a dose of optimistic naivety and my highly sensitive nature. The preparation of this vignette led to me first exploring this idea, even more candidly and colloquially, in a blog post [24]. There, I shared that upon entering Caltech, my kernel of hope came from two NASA missions (Cassini and Voyager) which induced a spiritual (re)awakening: the universe is mysterious, beautiful, and real, and more urgently, Earth and us Earthlings must stick together. I pursued aerospace engineering because the field, at its best, "helps connect humans to each other and all of us with our universe" [24]. However, my peacekeeper heart broke when I realized just how much of the industry is driven by the department of defense. On top of this harsh reality check, I was at nominally the "best" school for aerospace, which I soon realized is a highly subjective claim. My peers and I endured the fire hose of a first-year master's program, often compared to a 9-month hazing ritual. While the pedagogy was celebrated as "traditional" by some, to me, it felt more like a survival test than a space for meaningful learning. There had to be a better way, one that didn't conflate rigor with suffering but instead uplifted truly effective and inclusive methods. This led me to critical pedagogy, or "education as the practice of freedom" [8, 25].

I waited a full year after my first-year program ended to share my struggles and suggestions with a trusted mentor and leader within the program. She suggested I develop "an alter ego" so that I can portray the confidence necessary to succeed within the field, drawing a comparison to Beyonce's Sasha Fierce. I accepted the feedback that my self-doubt was evident and holding me back, but the advice on how to

overcome this pained me. What I needed wasn't an alter ego, I needed a way to navigate the system while staying true to myself. I needed self-compassion, not a perpetual performance. Telling myself it's normal to be scared, I have and will continue to do hard things, seeing my sensitivity as a strength, and accepting my imperfections as proof that I am only human allowed me to navigate challenges with much more composure and confidence.

I shared this story with the students in our Pilot Course to provide context and to share my own journey. Some described it as a pivotal moment in realizing this course was truly a space for vulnerability and authenticity. My experiences have led me to question and explore the purpose of education and STEM, especially how leadership, advocacy, compassion, and confidence are interconnected facets that shape a student's identity and community commitments. STEM students deserve the opportunity to develop their authentic humanity alongside their technical skills, which, in turn, makes them stronger scientists and engineers, empowered to contribute to the world in ways that are most meaningful to them.

Around the time of my dive into critical pedagogy and compassion, I was invited to be a panelist for a Drexel Society of Women Engineer's event I founded several years prior, *Lives & Lessons of the Underrepresented in STEM*. I started this event a year after experiencing sexual harassment throughout a co-op and having no tools to navigate this distressing situation. Once I began sharing my experience, it became evident just how common it was amongst my peers. *Lives & Lessons* was created to uplift voices, share stories and strategies, and bring all students into the conversation of bettering our STEM culture. At this fourth annual event where I sat as a panelist, a student had asked for advice on how to be a good advocate without burning out. This happening at an advocacy event that I had initiated was exciting and encouraging; I realized maybe I do have some worthwhile expertise to share. I reflected on what steps guide my own effective and enduring advocacy and provided a version of the present framework. The students loved it and followed up asking for a typed-up description. I then presented the framework at the Society of Women Engineers National Conference. After that, I took a course on "Effective Teaching and Pedagogy" at Caltech, where I turned the framework into a foundation for a course outline and subsequently formed a dream team to turn the class into a reality.

The pilot exceeded all my hopes and dreams. The community we built within the class, and the very real outcomes for the students and myself, made everything worth it. Having co-facilitators instilled in me the confidence to carry out my vision. Harly offered interdisciplinary wisdom from years of experience working with STEM students, and her belief in me and the program meant the world. I recall at the end of one class her exclaiming "it's moments like this that remind me of why I do this work". Morgan and Meredith's support, given our shared understanding of the space we operated within, helped me feel seen and valued, while their training in effective pedagogical practices was invaluable in turning vision into reality. For some students, this experience deepened our friendships that had already begun outside the classroom. For others, whom I had just met, we built new relationships, and I welcomed their perspectives to shift my own. In either case, witnessing the students' willingness to contribute to our shared space strengthened my belief that education can be reciprocal and transformative.

For me, this course and CAE study is an affirmation that I can and should keep doing hard things, being myself and growing in ways that are authentic to me and welcoming others into the fold. It has taught me about critical pedagogy in practice and growth through dialog, and the beauty of the liminal space between student and teacher. While I was literally both student and teacher during the pilot, I can carry this mentality in any role. As I look ahead, I see multiple possible paths. Whether it's expanding this work as a faculty member, taking it beyond academia as a nonprofit or business, or even shifting toward other sustainability efforts, I know that the heart of my work will remain: building community to learn alongside each other and create a world we wish to live in.

Morgan

I was involved in the development and planning for the Pilot Course, creating the course timeline and structure as well as facilitating one session and participating in another when I was able to be in the Los Angeles area.

The idea for this course came from Jacque, a visionary in the Social Change Ecosystem [18] we created as an instructional team to launch our Pilot Course. She had been thinking about how the graduate student experience can sometimes leave students adrift in the STEM space, losing the connection to communities, values or goals that had anchored us while diving so deeply into technical engineering and science goals. This was something I felt acutely as a graduate student, along with a hefty dose of Impostor Phenomenon (so present at our institution that I recall posters in the hallways which simply read "You Belong Here"). As a woman in a male-dominated field, I was able to find community through a supportive research group, a departmental student council, a Women in Aerospace group on campus, and later through a collaborative research project which focused specifically on issues of belonging, community and other Diversity, Equity and Inclusion (DEI) facets [26]. Connecting with peers who wanted to create social and cultural change in our program was the catalyst for my realization that community-based advocacy work may be a missing link in traditional engineering curricula, which could help to build students' wide-ranging interests, motivations and goals directly into the curriculum.

To address this gap, we (myself, now a faculty member, and the other facilitators) developed this course on Effective and Enduring Advocacy. We based it in critical pedagogy (for example [8]; [25]), a philosophy which resonated with all members of the instructional team, to disrupt the traditional flow of information from instructors to students; we hoped that by having students actively co-construct the course and the materials we discussed, we could create a space on campus where students could refocus on the communities and causes that had drawn them to STEM in the first place. Though at the beginning of the course I was worried we were unprepared, as we didn't have the same sort of rigid structure or plan that I was used to when teaching traditional engineering courses, it was even more successful than I could have imagined. The course came alive in the hands of the students, becoming so much more than we could have created without them.

Though there were many bright moments of connection, self-discovery and reflection throughout the course worth discussing here, one of the most striking features of the experience was the strong sense of community (including both students and instructors) it created. Looking back, though the actual content we discussed was interesting, perhaps what was more profound was that students' connections to that material were honoured by their peers, which in turn reinforced connections between participants. Starting very early in the course, we were able to establish a space where both students and instructors were vulnerable about their ideas, hopes and fears: hearing others' perspectives on the role of engineers and scientists in the creation of both collective and individual futures, so deeply connected to their lived experiences, was a powerful motivator for me to continue to grow my approach to advocacy work.

For example, one student shared their ideas about the importance of imagining a positive future as a motivating factor in their advocacy work (in particular, they imagined a solarpunk future which integrated both advanced technology and human/environmental considerations). Though I have engaged with ideas of utopia/dystopia and related topics through my love of speculative and science fiction, hearing those ideas re-imagined through our shared context, and in particular hearing the importance that this individual attached to imagining them as a goal rather than a fantasy was important for me; it has crystallized my approach to engaging with advocacy around the climate crisis (including current efforts to integrate sustainability through imagining a positive future directly into other traditional engineering courses I teach), and altered my own approach to advocacy in other spaces. As I identify most strongly as a builder

[18], having a positive vision (imagining not what I wish were gone, but what I wish were present) to build towards in the face of hard problems like addressing climate change, or creating institutional change in large organizations such as universities has already begun to enhance my motivation to continue my advocacy work.

More broadly, I believe that by offering a space within the curriculum where students and instructors could openly discuss these aspects of engineering and technology development which are generally termed 'sociotechnical' and therefore devalued within the traditional STEM enterprise [27], we validated those students who felt alienated by the technological focus of their higher education to date. As instructors, guiding this community of advocates as it took shape validated our own efforts as well; in parallel, allowing students to take on the role of guide as we enacted critical pedagogy in the classroom helped me create stronger connections to communities and advocacy foci both new and familiar, and to feel connected to my own identity as an engineer and as a builder in a deeper and more nuanced way.

Meredith

When considering the impact that this course has had on me, as well as what I observed in others, I came to realize that we had co-created a community of practice. This was not an explicit goal from the beginning of the course, but rather something that developed organically within the course. This was a revelation for me, since I am very familiar with a different, pre-established community of practice.

Outside of my role in developing materials for this course, I am also one of the co-directors of the Caltech Project for Effective Teaching (CPET). CPET was explicitly founded as a community of practice, where graduate students and postdocs who are interested in teaching come together to discuss, learn, and work on group and individual goals related to effective teaching. Although we are mentored by a staff member at the Center for Learning, Teaching, and Outreach, all CPET events are led by students. This creates a level playing field, facilitating multi-way knowledge sharing rather than the traditional one-way classroom model. There are three key aspects of a community of practice in the literature ([20, 21]). First, a community of practice must have a specific domain. There must be a shared interest among members, which for CPET is effective teaching. This is the main focus or main purpose of the community of practice. Second, there must be a true community. Members must feel connected to the group and feel like their contributions to the group are valued equally. In CPET, we foster community in two ways. We incorporate relationship-building activities like snack times and icebreakers. We also regularly engage in discussion and workshops where the goal is building shared knowledge. Last, the community must practice. The members must use the shared resources and knowledge as practitioners, weaving community wisdom into their own unique practice.

Despite my experience in the community of practice model, I didn't connect the dots about what we had created until the course was nearly complete. We had inadvertently created and sustained a community of practice through our course, including all three key aspects. The topic of the course itself fulfilled the first aspect (domain) and the activities throughout the course helped to fulfil the last aspect (practice), but the aspect that I think was crucial to the community of practice developing without our explicit cultivation was the community.

When you take a look at our positionality web, it's pretty intermingled. On my part, I had met all but one of the class members before the course began. These relationships spanned from years-long department friendships to previous CPET co-directors to new CPET attendees. Every class member entered the room knowing at least one other person, and I think that was a strong position from which to become socially expansive. The intermingled positionality web also meant that for all "instructors" except Harly, at least one person in the room knew them as a peer outside of an instructional role. This helped to level the

playing field between "instructor" and student, minimizing those distinctions which are detrimental to a community of practice. This made it easier for the students to take an active role in the community, sometimes acting as expert and sometimes as learner, contributing to community knowledge. The community was therefore inherently fostered from a place of social safety.

I also think that unintentionally having students who were already embedded in a community of practice framework eased the development of such a community. Matthew in particular, due to his role as a previous CPET co-director, was inherently primed to engage in that manner. He was one of the first students to jump on sharing extra resources, starting conversations, etc. on the discussion platform for the course. He broke the ice, as it were. In a future iteration of this course, where this lucky happenstance does not occur, intentional cultivation of a community of practice may need to be prioritized.

Harly

I came into this experience as an "outside evaluator," and I emerged as an included team member. Rather than simply observing the class dynamics, I experienced meaningful personal growth myself.

I hold a PhD in English, with particular emphasis on the study of narrative theory, constructions of collective identities, and rhetoric. These interests have endured and evolved over the last decade in my work as an engineering educator and engineering education researcher. As a faculty member in (and Associate Director of) USC Viterbi's Engineering in Society program, my teaching addresses the sociotechnical aspects of engineering as well as professional skills. My current areas of scholarship investigate students' transition to the workforce, mitigating engineering "stress culture," dialogical constructions of the self, and the value of study abroad programs for engineering students. In short, I bring a humanities perspective to engineering education.

I encourage my students to look for the blind spot in texts we read and technologies we discuss: what are the hidden biases and naturalized assumptions to which the creator is inured? My work on this project has helped me realize this: I tend to theory instead of action. The experience of working on this project has helped me feel the visceral power of action—of advocacy beyond the pages, of learning beyond the classroom. Despite being familiar with the work of Freire since graduate school, I had never implemented it as whole-heartedly as it was in the Advocacy course. That said, my teaching was formed in the composition classroom and informed by graduate courses in rhetoric and pedagogy; to this day, my teaching approach includes workshop and conference (one-on-one meetings) pedagogy– fertile ground for a Freirean approach. I hope to grow as an educator by embracing more fully the principles of liberatory and critical pedagogy that I experienced in this project and integrating them organically into my teaching methods.

My inclination to lean into theory, which as a form of intellectual detachment can be a weakness, however, is also one of my strengths. Throughout the Effective and Enduring Advocacy course, I attended several class sessions and the students' final presentations. Based on my experience in analyzing collective identities and investigating the role of narrative in identity construction, I could see the natural extension of the course's pedagogy with the research methodology of collaborative auto-ethnography. This method resonated with Jacque's interest in embracing participatory action research and inviting students to contribute directly to the research component of this novel approach to STEM education. My main contribution to the project, then, is offering this specific CAE framework for continued reflection, analysis, and sharing of our experience.

Maria

I am an undergraduate student in Chemical Engineering at Caltech. Studying at a university like Caltech creates a rather privileged perspective on pedagogy and education, specifically science, technology, engineering, and math (STEM) education. Studying within an engineering discipline rather than one of the natural sciences also provides a differing perspective from my peers. Additionally, being an undergraduate creates a narrower look at broader impacts, as I am simply unfamiliar with the greater world of academia. I also identify as Latino and was born outside of the United States, creating unique challenges in participating in American academia. Additionally, I am also a woman, leading to certain differences in how I interact with professors and pedagogy in a male-dominated field such as engineering.

– Background on why you were interested in the course, previous experiences with advocacy, belonging in STEM etc.

During my junior year, I took a course on sustainable engineering. As part of the course, we had a special guest lecture from Jacque regarding emotions in engineering. After the lecture, there was an invitation to attend a class focused on advocacy in engineering. As a future engineer, and as someone who was the Vice-President of the Caltech Hispanic Latino Association, I was interested in a class that would discuss how to organically introduce my advocacy into my day-to-day profession. I was also interested in how I could make my work with underprivileged Latino students more effective, as my advocacy was focused on introducing STEM into middle-school and high-school aged students, as well as the realities of higher education.

– Key lessons/learnings/takeaways from the course, either expected or unexpected.

It was interesting to be in a class full of graduate students as the only undergraduate in the course. Hearing the experiences of my upperclassmen and seeing the path that they have already tread; I was able to gain further insight into some of my career options. Prior to the class, I had not been considering a career in education. Hearing about my classmates' aspirations regarding professorship and science education was enlightening to say the least. It was also helpful to talk to other graduate students about what a PhD looks like. These conversations have led to me seeking a PhD (at the time of writing, still waiting for responses) with a goal in professorship, specifically one that focuses on teaching.

Besides these insights, I also wasn't expecting to learn about the different schools of thought regarding pedagogy. This was especially helpful as I was also working as a teaching assistant that term, and was able to immediately implement the pedagogical techniques learned in the course to be a more effective TA.

– What that means for you going forward.

From the course, I have learned more about the different kinds of advocacy that my future colleagues are interested in. I also realized from this course that I wanted to pursue professorship, specifically in a lecturer or undergraduate advisor role, so as to work with underprivileged minority students in higher education to help with STEM retention.

Matthew

I am a former Caltech graduate student (2018–2024) currently working as a lab manager in a science literacy outreach group at the University of British Columbia, Canada. I had many roles during my time at Caltech: a graduate researcher in a systems & synthetic biology lab, a program manager at the Caltech Center for Teaching, Learning, & Outreach, a student co-director of the Caltech Project for Effective

Teaching, and a union organizer and bargaining team member with Caltech Grad Researchers & Postdocs United–UAW. My advocacy journey so far has included work around climate action, labor solidarity, equity in STEM education, environmental justice and habitat restoration, and local food sovereignty. I studied at Caltech as an international student, having originally come from Canada. I identify as male and mixed ethnicity.

– Why did you join the class, what did you come in with?

This class was the last class I took at Caltech and I'm very glad to have concluded my time at Caltech with the best class I had ever taken. I first learned about the course when I met Jacque at a Center for Teaching, Learning, and Outreach (CTLO) workshop at which she was workshopping the syllabus for the course. I was excited by how the syllabus centered critical pedagogy in its design and how it explicitly made space for students to bring their own experiences, emotions, and hopes into the shared classroom. By both interacting with the syllabus and getting to know Jacque, I knew that I wanted to participate in the class. I came to the class during a busy and emotional period of transitions in my studies. On the one hand, I was coming out of a period of depression spurred by the pandemic, the ongoing local visceral reminders of the ongoing consequences of the climate crisis, and an overall mismatch in my day-to-day work and my concerns. Just prior to beginning the course, I felt I had started to find a way back into hope and action, largely through engaging with positive visions for a better future, specifically solarpunk literature and art. These media helped me reconnect with my values and coalesced a vision for a better world that I wanted to participate in creating. With this newfound purpose and energy, I had also begun to get more involved with causes and groups that I cared about. I started volunteering at a local community garden, joined volunteers in habitat restoration around Los Angeles, joined the bargaining team of our school's graduate and postdoc union, and began transitioning my work from cell biology lab work into science education. Even with all of these changes and building momentum, I had not yet talked about my motivations and positive visions for a Solarpunk future with any of my colleagues at school, fellow union organizers, or volunteer friends.

– How did the community influence your journey in the course?

From the first day of the course, it was clear that the group of students and teachers were committed to creating a vulnerable and trusting space to talk about our hopes, struggles, and desires in advocating for social change. We all shared a background in science and especially conducting science research at a technically minded, aggrandizing institute like Caltech. We openly shared our common worries about the relationships between science, engineering, and society, while also reflecting on how these worries appeared given our individual experiences and backgrounds. Our classroom was full of differences in our focus and how we were engaging with advocacy, but we shared a common drive to advocate for a more equitable and just world starting with our local Caltech community. Within the whole group, I found many peers whose visions and advocacy priorities aligned closely with my own. My greatest pleasure was working alongside these peers to advance our advocacy goals. I was able to help a peer who wanted to expand their role in our graduate student and postdoc union. Simultaneously, other peers were helping me to physically re-imagine a community garden space at Caltech into a place that supported local ecology and brought folks together to grow. Some of this work was material and literally involved getting our hands dirty - sheet mulching new garden beds and planting native plants to attract pollinators. Other work was more emotional and relational - talking about our feelings and hopes for what the future of our garden, our school, and our world could look like.

– What are your takeaways?

I came out of this class with a much clearer idea of the roles I want to play to bring about social change and the confidence to share my advocacy hopes with others in order to work together in making them a reality.

I found great joy in talking openly with folks about both my worries about the world and the ways I imagined it could be better. Then seeing how it was made better through collaboration. Finding a group of folks to check in with and work alongside made me feel more confident than ever that social change is possible when we work together and that I can play a part in making that happen.

Micah

As a PhD student from Hawai‘i, my love for science and technology originated from the distant observation of the cutting-edge technologies shaping the fields of aerospace engineering, combined with the fundamental math and physics courses that I took during my basic education. I would often look toward the US mainland as a place where I could seize opportunities to work in higher-technology fields. I grew up in a typical Asian-American/Pacific Islander household with value systems rooted in filial piety and respect, meaning that elders in my community were viewed as sources of knowledge. Furthermore, many of the virtues surrounding contemporary Hawaiian culture seemed to act dialectically with the virtues associated with higher education in STEM. Some aspects of contemporary culture in Hawai‘i seemed to place particular emphasis on cultural preservation and viewed external (particularly Western) viewpoints as a threat; since modern science is rooted in Western practices, I noticed a conflict between modern STEM practices and contemporary Hawaiian values and belief systems. For example, a common thread within modern belief systems in Hawai‘i highlights the importance of the land, or *‘āina*, as a source of sustenance and even worship; when critical scientific infrastructure to study astronomy was built at the summit of Mauna Kea, Hawai‘i’s tallest and most sacred mountain, tension rose between both groups, presenting an isolated instance of how the infrastructural tendencies of modern science clashed with native values. At the personal level, this clash manifested as a balancing act between my cultural and scientific identity, and not necessarily in the most stable manner. Within STEM, I often felt capable (in the sense that I felt able to perform calculations and tasks needed to be successful), but culturally lost; this imposter phenomenon felt inhibitive at times, even though I felt like I had the academic fortitude to be welcomed to my home institution.

This class enabled me to reflect upon and inject my previous experiences into my advocacy framework, and I was able to build confidence and validate my presence within a STEM PhD program. I was able to discuss advocacy and my sense of being in an environment where our interest in STEM and our desire to promote an advocacy framework were the primary threads connecting us, and having a class driven by participation and peer-to-peer learning was a welcome change to the traditional lecture-based styles observed in other STEM courses.

The basis of many of these conversations were sometimes introduced by peers, while there were others presented by experts in the field, and spanned topics such as values and roles in the STEM/academic sphere, confidence-based leadership, and giving and receiving feedback. Many of us furthered our discussion by introducing our personal connections and experiences with these topics. In many cases, my previous hardships with STEM (primarily associated with the dialectic relationship with traditional values and the objectives of STEM) were often validated through these discussions and learning that my experiences were worth studying and discussing felt incredibly reassuring. I could then use this reflection on these known values and catalyze them into a framework addressing the similarities and differences between traditional values and STEM objectives. While my approach was more reflection-focused, my peers often discussed their frameworks from an action-centered approach, which was also welcomed.

I feel that I am better armed with the tools necessary to continue with my advocacy journey. While there are certain challenges with my advocacy path (namely with respect to the universality, or lack thereof, of the values present in my home community and STEM experiences), I feel that I can give and receive

feedback and guide my peers in a balanced way; while my experience in the course placed more emphasis on reflecting upon my previous experiences, the course staff gave me the knowledge and confidence needed to distill my reflection into action. I really loved dedicating two hours a week discussing our journeys, thoughts, and challenges with friends, and these discussions/activities really catalyzed my sense of purpose within my graduate school experience.

Nina

– Why did you join the class, what did you come in with?

My early exposure to the power of advocacy has been focused on recruitment and retention of women in STEM. I started as an undergraduate mentor with the Georgia Tech Women in STEM group, helping my mentees navigate the barriers of imposter syndrome and self-doubt. As a graduate student, my advocacy work expanded to leadership initiatives, as president of Women in GALCIT (aerospace). I learned about E100 through Jacque, the course instructor, and a close friend and the founder and former president of Women in GALCIT. I was excited to engage with the role of an advocate more systematically and reflectively.

– How did the community influence your journey in the course?

My advocacy work prior to this class was rooted in action over reflection, due to my preference for learning by doing in many contexts. However, reflecting through this class helped me realize that this style of advocacy is reliant on existing structures and communities, which allows me to focus on tangible outcomes rather than deeply exploring the foundational aspects of equity, connection, and purpose. So, there were readily available and existing structures for women in STEM that I could easily step into. On the other hand, the topic I chose to focus on for the course– ecological health, and sustainable practices– had fewer spaces and resources readily advertised to graduate students. This motivated me to step outside of my comfort zone and be reflective instead of going straight into action.

I was paired with Matthew early in the course for a sharing activity. Jacque, our instructor, had thoughtfully paired us, sensing that our prepared topics would resonate—and she was right. During our initial discussion, I shared my love for The Overstory, a book where trees are central characters. Its appropriately pessimistic tone resonated with how I often feel about the destruction of our environment, and I shared that overly optimistic takes on how a climate future often annoyed me because it seemed like ignoring the problem we created. Matthew, in turn, shared his previous struggles with climate pessimism and how discovering the Solarpunk community helped him reframe his thinking. Our conversations, which continued throughout the course, helped me see that I can hold on to my disappointment and rage about the impact of previous decisions have made on the environment while dreaming of a better future.

Learning from Matthew's experiences I developed an interest in learning more about how a sustainable society can evolve with the assistance of technology rather than resisting them. This feels like such an obvious realization but felt especially important as an engineer who may be equipped to contribute to the technological developments that will shape the future. This was especially potent when I began to see how my views on sustainability and environmental connection were rooted in the experiences and teachings of my grandmothers which I still hold very dear but in practice resulted in my resistance to change and new technologies instead of allowing them to fuel my passions and desire to shape a different future.

I think that it is so beautiful that although the course syllabus did not include learning "climate optimism" and "how to maintain a connection with your grandmother" these were really empowering realizations that came about through a supportive and intentional community. In one example I learned about a movement

that has really inspired me directly from another student. In the other, struggling with nostalgia was a truly personal journey that I needed to lead for myself but was mediated by having a community which inspired me, held me accountable for my reflections, and pushed me in new and unexpected directions.

– What are your takeaways?

My development in this course is a clear reminder of the importance of community building. In a space shared by just ten people – four instructors and six students meeting weekly – I learned as much from my fellow students as from the instructors. Their experiences, perspectives, and openness challenged me to reevaluate long-held assumptions and encouraged me to approach advocacy with renewed clarity and optimism. In addition, it has given me a framework and language to better frame my advocacy journey.

Kay

I joined the effective and enduring advocacy course just a few months after arriving at Caltech for my postdoc, through a series of serendipitous introductions. I completed my PhD in chemistry at UC Berkeley, where I was heavily involved in activities related to diversity, equity and inclusion, and chemical education. These aspects of research and academia have been important to me throughout my chemistry career. At Caltech, I hoped to find a community of likeminded scientists. I met another student, Matthew, who was planning to enroll in the course through activities with the Center for Teaching, Learning and Outreach, and I was excited to find this group of people so quickly.

At Berkeley, I had designed and taught a similar course for chemistry graduate students, called *Scientific Responsibility and Citizenship*, that examined case studies in which basic research led to large societal impacts, and how the process and outcomes contained inequities to communities historically excluded from institutional science. Early in my scientific career, I struggled with gender-based harassment, and the pain of those experiences has shaped my approach to being a scientist. Alongside hoping that my research would have a positive impact, it was important to me that I would contribute to a change in the scientific community such that new researchers would not suffer the same experiences that I had. Scientific feminism has been an influential framework on my thinking and over the course of my career, my focus turned outward to the effects of science on society and how and whom science serves and harms. The effective and enduring advocacy course was much more introspective than the course I had designed. In this advocacy course, I had the opportunity to look inward and consider my journey and values, and the trajectory of the next steps of my career.

I appreciate that I had this community and this space at this time, the beginning of my postdoc, to think about these things. It was inspiring to see the passions and actions of my classmates and the ways that they carved out compassionate change-oriented spaces within the confines of a competitive program and institute that doesn't always elevate these values. The nature of advocacy and activism inherently involves a lot of pushing against things and it's easy to become jaded or worry that nothing we ever do will be enough. In this course, I was warmed by the optimism and idealism in imagining solutions and better systems, even if they are difficult to achieve. Being a part of this course in the time when I was trying to decide what type of career I wanted to pursue helped me envision ways that I could continue to make advocacy part of my career as I move forward, and the ways that my role can evolve.

I have often been concerned that pursuing a research faculty career in academia would be at odds with my values in equity, inclusion and education. The demands and metrics for acquiring funding, recognition, and career advancement in R1 academia generally privilege research productivity and output over mentorship and education, and I am resistant to compromising my values to meet these metrics. A teaching position

would allow me to focus more on education, but I also do enjoy research. In the first class of this course, we talked about the different social change roles outlined by Deepa Iyer, which was very helpful for me in thinking about how there are many different ways to contribute to a cause and that the roles I played in the past as a student can change as I advance in my career. Conversations with other students in the class and particularly one I had with Morgan helped me envision ways I can integrate my values into a career in academia. I gained more confidence that the values I hold can also take shape in the things that I do that are not explicitly related to activism and change. Instead of compromising my own values to meet the demands of a research career, a position of power could enable me to support the work of like-minded students who feel alone in their approach to STEM and to enact change at higher levels. In a faculty position I may have less time to spend on activism in the way I did as a student, but I would be able to provide institutional support to these causes, which is often lacking. Change is not always about overhauling old systems and creating new ones—though sometimes this feels necessary, it would take a lot more time and resources to achieve. In the meantime, change can also happen by "queering" the way we perform necessary actions within the existing system [28]. Structural change is difficult but the community I found in this course renewed my optimism and gave me inspiration to keep trying.

Appendix C: Author Information

We include a "quick reference" below which summarizes author information, and provides relevant context for our positionality in the Pilot Course and CAE. The individual Social Change Ecosystem roles offered [18] reflect those that resonated with us most during the Pilot Course, and those which we explored as they pertained to our advocacy; however, we keep in mind that these roles can evolve as we grow and encounter new spaces.

All graduate and undergraduate student positions mentioned below were held at the Pilot Course's host university (Caltech). For more detailed information on our positionalities, roles, and interconnectedness during the course, please see the Vignettes in Appendix B.

Author Info (Facilitators, Students)
Name
Social change ecosystem roles (Iyer, 2022)
Position during Pilot Course
Current or previous position (if relevant)

Morgan Hooper
Builder, guide, frontline responder
Assistant Professor, Teaching Stream at the University of Toronto
Previous graduate student (Aero), graduated 2022

Meredith Hooper
Builder, experimenter
Graduate student (Aero)

Maria Jose Azcona Baez
Healer
Undergraduate student (Chem Eng)

Nina Mohebbi
Visionary, weaver
Graduate student (Aero)

Jacqueline Tawney
Weaver, visionary, caretaker
Graduate student (Aero)
Current adjunct professor

Harly Ramsey
Storyteller, guide
Associate Professor of Technical Communication Practice and Associate Director of the Engineering in Society Program, Viterbi School of Engineering, USC

Kay Xia
Weaver, visionary, builder
Postdoc (Chemistry)

Matthew Langley
Builder, guide, visionary
Graduate student (Biology)
Current staff at University of British Columbia: Science education and outreach lab manager

Micah Nishimoto
Visionary, experimenter, weaver
Graduate student (Aero)