ASEE 2022 ANNUAL CONFERENCE
Excellence Through Diversity
MINNEAPOLIS, MINNESOTA, JUNE 26TH-29TH, 2022 ASEE
Paper ID #37948

STS Postures: Changing How Undergraduate Engineering Students Move Through the World

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Abstract: This paper presents the application of a teaching strategy we are calling "Science, Technology and Society (STS) Postures," that is used to help engineering students conceptualize socio-technical systems. STS Postures integrate three modes of doing: 1) Body/Mind fusion; 2) Data collection techniques; and 3) Systems thinking skills. STS postures takes a traditionally passive educational environment and introduces movement and change making to the engineering curriculum. Instead of sitting in seats in the classroom, we encourage students to move about. We try out different ways of holding ourselves and moving (literally our bodies) in relation to each other, STS, engineering, education, and technological artifacts. This change in posture is key to having agency in directing the future of science and technology, whether in their own education, their extracurricular work, or their careers. Body/Mind fusion is a corrective to thinking in science and engineering that separates the body from the mind, which reinforces counterproductive ideologies (e.g., depolitizication) and mindsets (e.g., technical narrowness, "the myth of objectivity") in engineering. We encourage students to connect intellectual endeavors with emotions, performance, proprioception, enteroception, metacognition, and play. Data collection itself is a form of movement that involves BodyMind abilities; put differently, how would we collect data without BodyMind? We teach a pallet of qualitative data collection techniques, such as document analysis, interviews, natural observation, participant observation, focus groups, visual image analysis, and metaphor analysis. These skills help students embrace a "systems thinking mindset" that involves understanding how to: 1) listen contextually; 2) find ethics in artifacts; 3) make meaning; 4) seek stories about science and technology's past, present, and future; 5) locate power in systems; 6) ask STS questions; and 7) host STS parties. We reason that if students can take some of these data collection skills and mindsets into their engineering classrooms, internships, and careers, we will have given them life-long tools of interruption for responsibly interrogating their interactions with science and technology. This paper provides examples of STS Posture activities that are used within a required engineering ethics course.

Introduction

Engineering education research scholars in the Liberal Education/Engineering & Society (LEES) Division of ASEE and science and technology studies (STS) have generated a rich literature that describes the ways that social structures encourage the socio-technical divide, meritocracy, catering to corporate and military interests, technical narrowness, and the depoliticization of science and technology within engineering education institutions [1-5]. These prevailing social structures create a culture of disengagement from public needs [6-8] and instrumental thinking that reduces the ends of human relationships with technology to decontexualized productivity and efficiency outcomes [9-12]. This engineering culture produces a student body that doesn't question the educational system they participate in, one that has largely become the handmaiden of corporate and military interests [13]. In many ways, engineering students, especially those that stand to benefit from the status quo, become passive agents, consuming prevailing ideologies and going into a workforce that is aligned with those ideologies. Other students recognize that things don't seem quite right or that their values (e.g., improving human well-being, social justice, etc.) don't align with those of engineering education. They rarely find alternatives within the engineering educational system and often leave for occupations that fulfill those missing values. Others recognize these issues, but for a variety of reasons, just stick it out [14-15]. How do we create alternative pathways in engineering education for students? How do we encourage students to question the status quo of their education? How do we move them beyond technical narrowness to socio-technical systems thinking? The challenges to disrupting the status quo or providing alternative pathways are numerous. But a recent body of work has begun to propose and implement a variety of interventions under the rubric of socio-technical systems thinking and/or social justice [5], [16-21].

Building on this emerging area of pedagogy, this paper is a reflection on our experiences with integrating a systems thinking approach we call STS Postures within a required engineering ethics course. This approach "involves holding a reflexive posture that orients the body toward humility, openness, criticality, and action" [22, p. S118]. It aims to disrupt passive learning by bringing movement to STEM education. Ultimately, we want to change student posture as a way of empowering them to question the status quo and imagine diverse and alternative directions for science and technology. We originally developed this approach for a select Science, Technology, and Society living learning community that caters to STEM majors at the University of Maryland College Park [23]. This paper isn't a systematic analysis of this intervention. Rather we focus on introducing the theoretical foundation for STS postures and offer a few initial reflections on extending it to an engineering ethics course that is comprised of mostly electrical or computer engineering majors but is also open to a more general population of engineering students. First, we provide an overview of the STS Postures approach and situate it in the literature. Second, we describe the engineering course in which it is currently being applied. Third, we provide specific examples of STS Posture interventions. And finally, we reflect on some of the successes and challenges to implementing STS Postures in a general population engineering ethics course.

Situating STS Postures

The origin of the STS Postures approach lies with our struggle to connect with STEM students through traditional STS pedagogies (e.g., [24-25]), especially engineering and computer science majors. The realization (and continued evolution) of STS Postures is a culmination of influences from several bodies of literature and practice. The LEES critical engineering education literature deftly articulates the struggles we were having (e.g., [1], [3], [4], [16]). We also had developed a relationship with the Academy of Innovation and Entrepreneurship at the University of Maryland, who taught us how to integrate empathy building skills and data collection techniques into our curriculum. During this time, Mogul introduced Tomblin to John Schumacher's [26] book, *Human Posture*, a meditation about the influence of human postures on the power relations of knowledge production that calls into question our traditional mind-based approach to knowing and reflecting on science and technology. This book inspired us to introduce movement and encourage student agency in their academic affairs. On a broader level, STS Postures is an outgrowth of STS's branch of activist-oriented endeavors to discover alternative pathways toward a more just science and technology that serves humanity and the nonhuman world in all its forms [27-29]. The entanglement of these influences, plus the subsequent creation of the STS Critical Pedagogies collaborative (e.g., [19], [30-31]) helped us build out what we call STS Postures.

What are STS Postures?

In his book, *Human Posture: The Nature of Inquiry*, John Schumacher [6] gives the example of bees dancing as a way of giving directions to each other about critical locations (such as the hive or food). As a philosopher, Schumacher was building off his discipline's use of the word "posture" going back to Plato, who believed it was intertwined with the human ability to reason. Insights from cognitive psychology and neuroscience, however, illustrate how inextricable lived experience is from thought, bias and posture. In this sense, our use of the term helps students awaken their senses to self-awareness and the ability to self-actualize, while at the same time attuning them to implicit biases that continuously structure and categorize new information. By training students in mindfulness and theater techniques we are asking them to access their own self-awareness/consciousness (metacognition). This step is essential to becoming a catalyst for sparking conversations about ethics in daily practice – a step for which an ability to communicate with diverse audiences is not only tolerated but valued as a necessary skill for creating engineering designs that increase social equity. Schumacher saw this as a collective endeavor ("together-stepping"), which makes for a constructive counterpoint to the individualistic, merit-based culture of traditional engineering education.

STS Postures, as we have conceived it, integrates three modes of doing that encourage engineering students to have agency in their education and careers: 1) BodyMind fusion; 2) Data collection techniques; and 3) Systems thinking skills. The aim of this approach is to disrupt the traditionally passive STEM educational environment and introduce movement to the engineering curriculum. We lead students in "stokes" that, building on the methodology we learned at the Stanford d.School and also from theater improv, are much more than warm ups. They make possible different ways of holding ourselves and moving (literally our bodies) in relation to each other, STS, engineering, education, and technological artifacts. This change in posture is key to getting students to find and use their agency in directing the future of science and technology.

The Body/Mind fusion helps break students away from predominant ideologies in science and engineering that separates the body from the mind, which on their own reinforce counterproductive ideologies (e.g., depolitizication, [3]) and mindsets (e.g., technical narrowness, "the myth of objectivity," [1]). Instead, we encourage students to connect intellectual endeavors with emotions, performance, proprioception, interoception, metacognition, and play (Table 1). For example, one can introduce emotions and interoception into the engineering curriculum by asking students to observe how they feel when they experience feats of engineering, such as sitting in traffic, riding a bus, and paying attention to sounds generated by everyday technologies.

Table 1 – Definitions of Body/Mind skills.

Play	A distinctive trait of human beings which manifests as different types, functional, constructive, dramatic, games with rules that vary in complexity, competition, chance, and mimicry [32].
Critical Play	Critical play refers to play or games that spark creative expression, are instruments for conceptual thinking, and tools that provoke us to grapple with social issues [33].
Interoception	Consciously or unconsciously, this is our ability to sense what is happening internally in our bodies [34].
Proprioception	The ability to sense and perceive the movement and spatial orientation of one's own body.
Metacognition	Thinking about thinking. Metacognitive practices increase students' abilities to transfer or adapt their learning to new contexts and tasks [35].
Emotion	"A complex reaction pattern, involving experiential, behavioral and physiological elements. Emotions are how individuals deal with matters or situations they find personally significant." (https://dictionary.apa.org/emotion)
Orientation/ Disorientation	Related to social norms. This capability allows one to recognize the newness of novel situations when it is happening, or to take a beginner's mindset approach to familiar situations. An important step in being able to disassociate thoughts from self.
Performance/ Improvisation	Learning to act is a process of humanizing, learning how to be alive and gaining lasting empathy for others [36]. Improvisation peels away layers of self, focuses attention on the body and present moment, and invites people into deep collaboration with each other and the unknown [37].

Table 2- Systems thinking is a set of seven skills and corresponding STS concepts used to understand the practice and application of science and technology from alternative perspectives. This is not an exhaustive list of potential systems thinking skills. It represents how we approach systems thinking.

Looking for Ethics in Artifacts - Requires an ability to see how the same *thing* (a product, material, artifact etc.) can have different impacts on different people or be interpreted differently by different people. This skill is enhanced when we learn to pay acute attention to all our senses. *STS Concepts: Politics of Objects [38], Material Participation [39], Actor Network Theory [40].*

Listening Contextually – Requires one to be fully present and empathetic with whatever is being listened to, whether that be a person, a product, system, or something else. When someone is listening contextually, they realize a deeper level of connection to who and what is being listened to. *STS Concepts: Co-constructive Design [41].*

Making Meaning - Requires the meta-cognitive work of paying attention not only to what someone is saying, but also to what it means to that person, and also your own interpretation of it. People who listen contextually can design better systems because they are able to call into question their own assumptions and interpretations, and then use curiosity to test the validity of their own assumptions and try out new ways of framing data for new understandings. *STS Concepts: Interpretive Flexibility [42]*

Seeking Stories about Science, Technology and Engineering – Requires us to ask: how did we get here? What socio-political conditions helped or hindered its development? What are the different socio-technical imaginaries and how do they motivate people to pursue lines of inquiry and create things that cause change? Any cutting-edge science or technology has predecessors, which were made possible by people making decisions in favor of this possibility over others. *STS Concepts: Soico-technical Imaginaries [43]; Narratives and Counternarratives [44].*

Locating Power in Systems – Requires putting science, technology and engineering into institutional perspectives. This means tracing facts and artifacts as they journey around university systems, corporate research and development, local, state and federal legislatures, international treaties, and global economies. *STS Concepts: Standpoint Epistemologies [45-46], Technological Fix [47].*

Asking STS Questions - Requires all the other systems thinking skills to pose deeper questions about why things are the way they are, and how we might change them. *STS Concepts: Reflexivity [48].*

Hosting STS Parties - This can happen almost anywhere and requires one to set up immersive situations in which people look at science and technology from fresh perspectives. This means becoming a confident facilitator who can make people comfortable expressing their views and asking new questions. *STS Concepts: Public Engagement with Science and Technology [49-50].*

Data collection itself is a form of movement that immerses students in several BodyMind exercises at once. It helps students visualize the world as socio-technical systems full of politics, culture, and social relationships. We model a range of qualitative data collection techniques that includes document analysis, interviews, natural observation, participant observation, focus groups, visual image analysis, and metaphor analysis. These skills help students embrace a systems thinking mindset by offering specific paths to changing perspectives on a system. Seven systems thinking skills provide an STS conceptual foundation to the curriculum (Table 2). The aim here was to both de-jargon and transform abstract STS conceptual frameworks into action-oriented skills and mindsets. For example, the systems thinking skill "finding ethics in artifacts" relates to STS concepts such as the politics of artifacts [20], [38], [40] and material participation [39]. "Hosting STS parties" draws from the long STS history of encouraging public participation in shaping the future of directions of science and technological design and implementation [49-50]. Below we provide more extensive illustrations of how we integrate STS postures into an engineering ethics course.

Engineering Ethics at UMD

ENEE200 is a required course that Electrical and Computer Engineering (ECE) students may take in any year of their major. The ECE Department manages and pays for the course and the Undergraduate Teaching Fellows (UTFs). A typical class is between 75-110 students, with lab sections of 15-18. Weekly there is 150 minutes of instruction in lecture and 75 minutes of lab sections, run by UTFs. Preliminary data shows they are taking it during their sophomore and junior years. The department uses assignments from the course for their ABET accreditation process. In the context of the techlash, pandemic, and structural racism, the A. James Clark School of Engineering is moving towards requiring the course (which has two types of General Education credit), for all engineering majors (ENES200). At this point we are doing the administrative work necessary to scale up the class, such as hiring new instructors, identifying the best rooms for an "ethics labs" and requesting upgrades to existing classrooms. The ECE Department, happy with the current structure and instructors, has asked to keep the current configuration as an ENEE200 class with the same instructors. As expected, though, the bureaucratic work to make this shift has not been straightforward.

The required course textbook is *The Ethical Engineer*, by Robert McGinn [51], which we chose because, contrary to many other engineering ethics textbooks, does not overly rely on the deontological and utilitarian ethics literature to teach students to think critically about engineering. Instead, McGinn introduces "Fundamental Ethical Responsibilities of Engineers," based around considerations of harm, and within which John Rawls' Theory of Justice is incorporated to draw attention to the need to not externalize harms on already marginalized/vulnerable communities. Furthermore, and echoing Schumacher [26], McGinn begins *The Ethical Engineer* with a discussion on pedagogy, which we use to amplify our message to students that they will be continuously invited to critique pedagogy as part of their training to become ethics instructors. We explain that as students they are not only foundational to the course, but they themselves are on the ENEE200 teaching team, which is why we ask them to describe a teacher who impacted them.

From the first day of class, students learn that our course goal is to equip them with the ability to cultivate conversations about ethics amidst their daily lives (personal, political, professional). We earnestly call this "hosting STS parties"; during the course, as they grapple with the intensity and intractability of the large-scale problems that technology has perpetuated (misinformation, polarization, war, white supremacy) they learn that their agency is related to their ability to surface difficult questions with their peers, subordinates, or superiors. This simultaneously lowers the bar for what it means for them to be agentic in the context of ethics, while taking seriously the issue that raising ethics in everyday life is not a small feat.

Table 3 - ENEE200 Learning Outcomes

- Discuss political, social, economic, and ethical dimensions related to design, construction, and maintenance of technological systems
- Go beyond simplistic explanations to explain ways that stereotypes impact engineering, engineering design and technological development
- Define basic terms, concepts, and approaches that experts employ in studying socio-technical systems in order to achieve better outcomes
- Critique case studies and create your own based on current events
- Communicate to peers and a general audience your perspectives on ethics and engineering, and the roles that engineering and technology play in creating, perpetuating, and solving the most pressing issues of our time

The pedagogical approach is founded upon developing student capacity for "systems thinking" through the STS Postures approach (See Table 3 for ENEE200 Learning Outcomes). Students prepare for each class session in a variety of ways, such as: conducting a short interview or an ethnographic observation, reading and annotating a text, taking and analyzing photographs, drawing a storyboard, listening to a podcast, contributing to an on-line discussion, or a variety of other activities during which they interact with specific technologies in content (for example, auditing the buildings they use on a random day for their accessibility to a person using a knee stroller). Our experience is that students find these activities both engaging and uncomfortable. We use the discomfort to springboard discussions about course content and about the role of pedagogy in teaching ethics.

Content wise, the class draws on emerging technologies and controversies from all engineering fields, but also, because the case studies draw on emerging technologies, it has broad appeal to students in any major. For example, students study issues such as cybersecurity, net neutrality, high frequency trading, technologies designed to be addictive (including engineered food), police body cameras, UAVs (drones), whistleblowing, the design of emojis, the space shuttle Challenger, and the security of on-line dating, giving it appeal to any student interested in thinking rigorously about the benefits and challenges of a high-tech society.

Integrating STS Postures into Engineering Ethics

We'll describe two different interventions used in this course that embody the three facets of STS Postures: body/mind practices, data collection techniques, and systems thinking skills. One is a norming practice that is incorporated into many modules and the other describes a module on techno-ableism that was developed in an ongoing collaboration with our colleagues Yewon Lee and Aggie Hu in the Disability Studies minor. These two examples demonstrate how literally we approach movement in the course and how helpful it is to reorganizing students' bodies and attention towards our course learning outcomes. From a pedagogical standpoint, we highlight these examples to show how our skill-based approach relies on practice/repetition and student agency. Just like any habit, reflexivity needs to become second nature. These activities also give students tangible pathways for critically engaging with and changing existing systems.

Norming Movement, Changing Postures: In the first case, we norm students in the first week to the idea that body movement is integral to the course content. During the first lecture we present the body/mind skill of disorientation/orientation, which we tell them is a point of departure to personally navigate the course. They are asked to continually take on disorienting perspectives and then re-orient, which norms students to the life skill of psychologically adapting to changing circumstances. The first act of disorientation happens when we explain our course norm of collaboration and inclusivity, which is a departure from the traditional lecture format that encourages passive, individualistic learning (Slaton 2015). As one student put it, "I think that…one of my biggest takeaways from this class, [sic] is that engineering is not something you do alone. So many of my classes… I had just worked alone on everything, but this course was a refreshing reminder that this career path isn't supposed to be that lonely."

To activate disorientation, the first-time students turn to meet their groups they are asked to stand up and make a gesture of welcome to their group… "as if this were your space and we are all entering into it." Next, we connect the skill of disorientation/orientation to the systems thinking skill of "finding ethics in artifacts" ("politics of artifacts") in the classroom, calling their attention to the chair they are sitting in, the configuration of furniture, and to the classroom as a whole. This activity can be launched in multiple ways, either having students looking around, asking them to walk around the room with a partner, or drawing the room on a piece of paper or whiteboard, all of which have students practicing ethnographic data collection techniques (e.g., participant observation, visual representation). After we have debriefed their findings, we ask them to take on a posture of disorientation that they will show to their table mates, e.g. "At the count of three, make a gesture that shows disorientation" and then we go on to do the same for orientation. If anything, this gets students out of their heads enough (and possibly uniting against their strange professor) to experience our take home message in their body. In subsequent class periods, insights from this activity help critique other educational infrastructure we use in the course, such as the university's learning management software (ELMS), for its (in)ability to foster our course norms of meaningful feedback, collaboration, or, to use the older ABET term of art, "life-long learning."

Small activities in the large lecture are reinforced in weekly labs, in which students gain familiarity (and with time, comfort) with moving their own body in a group. The UTFs are hired based on their comprehension of how the active stokes are not cursory to our topic of ethics but are foundational to the skills of an ethical/systems thinker. Each lab has a multiple active stokes, the first of which is "Name Game with Gesture," a traditional warmup we use to emphasize the importance of the body/mind skills and the systems thinking skill, "listening contextually." Our teaching fellows practice this with each other, receive detailed instructions, and watch a video demo with examples of bad and good facilitation of this stoke. Movement and gesture slowly become a norm in the classroom, and we hear students start to explain that while they don't necessarily enjoy these activities, they see how they change the energy dynamic in the room and help make it an inclusive space for generating ideas about ethics. Here is one student's reflection on how these activities impact their learning:

> As this semester wrapped up, I was continually surprised by new activities in discussion. Through the semester, discussions were always dynamic and kept us on our toes. One week we would be mirroring a partner's body movements, and the next we would be leaving the classroom to interview random students about their thoughts on infrastructure. One challenge I initially faced because of this inconsistency was how to mentally prepare for discussion. For my typical technical classes, I would prepare by having questions ready for my [UTF] and being in a mindset to take notes quickly. For this course, I learned to come into discussion with no expectations. I became more and more comfortable sharing with [my UTF] and my classmates, and we grew together intellectually and emotionally.

This same principle is employed throughout the semester with activities such as mirroring, very lightning quick skits of a scenario they have written, or a few minutes of a skit in which they alternate playing, for example, a whistleblower or a person with whom the whistleblower consulted in the lead-up to the whistleblowing. Importantly, we regularly show students a slide of congratulations after they have practiced a given skill: "Congratulations, you just practiced orientation and disorientation!" This method enacts our approach of "meeting students where they are" as no matter what level of success or failure they experienced; they can contextualize the activity as *practice to build a skill*.

***Empathy and Human-Centered Design*:** The second intervention we present is a module on techno-ableism, which emphasizes the systems thinking skill of "locating power in systems." This activity is accompanied by a guest speaker Adith Thumalapalli, a mechanical engineering major that graduated in 2020, who illustrates through his activism how one can make changes in an existing system. While at UMD, he inventoried campus buildings and issued a detailed report on the gaps in wheelchair accessibility. Either before or after Adith speaks to students, we give them a bracelet to wear for 24 hours that reminds them of their homework: to imagine they are hosting a friend from high school that day, and the friend is using a knee scooter to get around because of a sports injury. From the time they leave the classroom, they are asked to navigate the campus with this friend. Even while they are still in the classroom, students start chatting with each other, realizing the obstacles they will face just even exiting the building. This activity uses the data collection technique of participant observation as well as the body/mind technique of orientation/disorientation. Students read and discuss Ashley Shew's [52] essay, "Different Ways of Moving in the World," and report back how the impact to their schedule sensitized them to infrastructure more deeply. Despite reporting varying levels of participation, from the student who more or less forgets about it until the write up is due, to students who reports completely altering their schedule because of the accommodation, students mark this as a time in the semester where they really take on a different perspective:

> The lecture that resonated with me the most was when Adith was our guest speaker. I would say that I was ignorant to the problems faced by people with disabilities before this. I never thought about how hard it might be for them to do things like go to class, etc. and this really helped me think about that. And this is important as a future engineer to think like this and be inclusive when building, creating and designing.

Disability simulations must also be critically unpacked with the students. Some start this on their own, wondering whether such simulations represent people with disabilities as passive consumers of their environment. We enable those critical voices within the discussions to problematize our own pedagogy and framing. This helps the class see such simulations as an artifact of education that should be interrogated; in STS Posture terms, “looking for ethics in artifacts.” For this reason, we are committed to an ongoing collaboration with disability studies, being open to refining this module in a way that preserves people with disabilities as agentic rather than reifying the dangerous framing of people with disabilities as disempowered or solely vulnerable (“locating power in systems”). We ask students, what is problematic about this activity? How could it be done differently? What additions would you make? What are completely new ways of arriving at this perspective? Either for homework or in-class, we ask students to take an agentic posture, for example by defining and reporting a particular issue to the facilities management, or by submitting comments to the provost’s survey on campus life. We know this is a highlight of the course because students write about it in their final reflection as a point of deep learning for them. For example:

> Everyone can be an advocate for a more including [sic] community. I could join a club that promotes inclusivity and discuss problems that people face with inclusivity or lack thereof and propose/design solutions to those problems. Another way would be to identify places of inaccessibility and report them to the official ADA coordinator for the UMD campus.

Discussion: Reflection on Successes and Challenges

Students (and professors!) need continual practice to embody any habit or skill. We are learning how to be literal and deliberate with students in the classroom when teaching and practicing these techniques and to continually call attention to their relevance to professional practices. During the last class at the end of our first semester using STS Postures explicitly, a student asked, “what is proprioception?” Sure, they may have missed a session when this was defined, or they may not have been paying attention when it was defined, but this has helped us to continually define terms and provoke students to think in terms of their application. Now, when we introduce a new term, we give a definition and announce we are going to practice it. Once the activity is done, students are asked to self-reflect (with sentence stems) for a few minutes, e.g. “*What I learned about myself from doing this activity is…*”, before rejoining a group to discuss what they just practiced and learned. We cap it off with a congratulatory slide: “*Congratulations, you just practiced critical play!*” We will ask them to “practice orthogonal thinking” by answering questions such as, “*How might this skill be relevant to the professional practice of engineering*?” Or “*How might this skill be valuable in your future workplace or career?”* Neither self-reflection itself, nor note-taking as a method for self-reflection, is normed in engineering education. Therefore, we are learning that along with continually re-introducing and re-defining terms, we should dedicate class for quiet reflection. Often, we follow this with discussion, and frame these skills in the context of *practice* (rather than mastery). In our third iteration of this rollout in the ethics course we aim to have each term incorporated multiple times in lecture and lab.

One of our most successful modules – based on the number of students who incorporated this into their final reflection – was on techno-ableism and this has helped reveal to us challenges around teaching students not simply how to have empathy, but to practice cultivating situations in which they will gain empathy. Because their ethnographic observations were preceded by a guest lecture given by a recently graduated UMD mechanical engineer, this activity seemed to be a lot more meaningful. To the extent possible, we hope to replicate this formula -- guest speaker who connects to students' experience + active learning -- to meet other learning objectives. We are grateful to our colleagues at the Academy for Innovation and Entrepreneurship for an insight about creating empathy through simulations - that asking students to devise another way to gain empathy is as important as the activity itself. Empathy itself is not the destination – we want students to be able to design their own experiments to change perspective and cultivate empathy.

What will STS Postures look like at scale? To offer this course to every engineering student, we eventually need up to 6 additional instructors and 30 more UTFs. Our preliminary experience gives us hope and encouragement, but to succeed at scale all our instructors and UTFs need to embody this pedagogy and land the message to students that it is a valuable pathway in professional development. We are addressing UTF qualifications by creating a 3-week training curriculum and requiring them to visit each other's classrooms in the first three weeks of the semester. One of the primary considerations for hiring a UTF is their ability to connect the STS postures to course learning outcomes. In advance of the Spring 2022 semester, we implemented the curriculum and believe that our current 12 UTFs understand their role as both implementing curriculum and continuously self-reflecting on their own classroom practices. Each week we meet as a team in a classroom to run through the week's lesson plan and to do the active stokes together to ensure the best possible implementation and debrief. We gave the UTFs notebooks and assigned them 10 minutes of reflective writing on Fridays after their session, plus one observation of another section during the first three weeks of the semester. Our preliminary experience is showing that the three weeks of training, the self-reflection and the observations are creating a more collaborative environment for the teaching fellows. They are quicker to adjust their classroom practices and seem more flexible in the classroom (e.g., *the projector wasn't working at the beginning of class, so we just did the AV Scenarios handout until classroom support arrived*). Importantly, using tools of mindfulness, our UTFs now approach students with increased patience, humility, and curiosity, which seems to result in improved student engagement with both activities and their debrief.

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