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# Faculty Workshop on Teaching Sustainability

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# Faculty Workshop on Teaching Sustainability

Despite the urgent need to integrate sustainability throughout the engineering curriculum, most faculty have little to no training or confidence in doing so.  We report on a 4-day pilot faculty workshop delivered in January 2023 by an interdisciplinary group of faculty at a large mid-Atlantic R1 university designed to help engineering instructors do this.  After substantial effort to create a mutual understanding around the diverse approaches we as faculty bring from our respective disciplines, we decided to follow a "spiral model" for the workshop, in which an initial introduction of a concept, skill, or consideration was later revisited, sometimes multiple times, to deepen the conversation in each iteration and to show their interconnectedness.  In addition to introducing sustainability learning outcomes (LOs), including LOs for diversity, equity, and inclusion (DEI), we demonstrated tools such as life cycle assessment and socio-technical integration, considered new ways to think about assessment, and shared information about various sustainability topics.  Emphasis was placed on the development of students' critical thinking, socio-technical systems thinking, and sense of agency.  Demonstrations were integrated as a method of teaching, and mental models were introduced.   Examples were shared by faculty who had already begun to incorporate sustainability concepts into their courses.  During the workshop, the participants planned concrete changes to their own courses and discussed changing the curriculum across the 4 years of the undergraduate experience.

**Background**

Traditionally, sustainability has not been part of the standard engineering curriculum. By sustainability we mean meeting human needs (current and future) within planetary boundaries, covering social (including diversity, equity, and inclusion, DEI), environmental, and economic aspects. As an additional challenge, various disciplines across the campus are siloed, so that students in business, the arts, engineering, journalism, etc., do not communicate, although they will need to work together in the future to create viable new paths forward. A hurdle to curriculum change is that faculty have not been trained in sustainability concepts and typically do not teach across colleges. They are also unsure of how to address DEI, not wanting to get it wrong and cause harm as they experiment in the classroom. Some programs have therefore taken a "train the trainer" approach, holding faculty workshops [1, 2]. The effectiveness of such workshops is not altogether clear; for example, instructors' confidence in identifying effective ways to include sustainability into their courses may not increase. We focused squarely on equipping faculty by providing demos and boosting confidence.

The extent to which faculty are informed about sustainability topics, are comfortable using pertinent tools, and can develop student capabilities varies considerably. Regarding high-level learning outcomes such as critical thinking, socio-technical systems thinking, and student agency, assessment is a challenge that has received little explicit attention in many curricula. One approach that was advocated for the workshop was to formulate our work as alternating quick demonstrations of new techniques with periods during which participants try out how that might look in their own course. It is a given that faculty have limited time in their classrooms to add content – what we were aiming to do is to show them how adapting exercises that stimulate socio-technical thinking can help them achieve their other goals in the classroom, such as building strong teams, adopting a growth mindset, and supporting students.
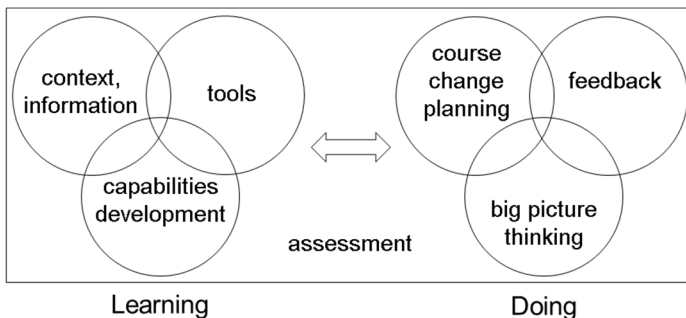


Figure 1. Workshop elements for teaching sustainability.

Because multiple touchpoints throughout the curriculum are required to solidify student learning and to give a subject importance, the aim of the authors' work is to introduce sustainability concepts into every required course in the undergraduate curriculum within the next couple of years. A longer-term goal is to create cross-college courses in which different majors work together on projects, so that students benefit from experiential learning and understand the need for different approaches to problems. For engineers, this means considering solutions other than technological ones and including the voices of those affected by proposed solutions in designs (a DEI learning objective).

**The Team**

The authors worked closely together to develop a pilot workshop for faculty with the aim of introducing sustainability concepts into all required engineering courses. This team of seven comprised three in the Department of Mechanical Engineering (ME), one from the Department of Civil and Environmental Engineering (CEE), and two from the Science, Technology, and Society (STS) program in the Engineering College, and one from the College of Education. It included both tenure and professional track faculty. Two of the members were, or had been, Directors of Undergraduate Studies (DUGS). The four Engineering School team members (first four authors) had been working together previously on a grant from the Lemelson Foundation and Venturewell, as one of five universities in the Engineering for One Planet (EOP) [3] pilot program, which had developed a set of learning outcomes in the Engineering for One Planet (EOP) framework [4]; these formed a starting point for the workshop.

**Workshop Planning**

The diversity of views and expertise on the team, while a strength, meant a period of learning each other's "languages", approaches, and perspectives. Initial conversations were about the purpose of the workshop, how we might assess its success, how we might engage in co-development, and specific activities that each organizer wanted to include. This culture-building lasted for several months as we worked through our different visions for the workshop. Initially conceived as having a format of presentations followed by time to work on courses, the idea emerged to integrate demonstrations as a means of teaching and to explore new tools for change, aided by examining mental models. With the workshop we wanted to achieve several disparate things (Figure 1): 1) conveying basic information about topics in sustainability, the available tools for quantification, and resources for change; 2) community-building; 3) new pedagogical experiences for the faculty; and 4) helping faculty visualize and plan concrete changes to courses.

As we planned the schedule, a concept for a "spiral" introduction of material took shape. To reduce the burden of overloading faculty participants with new terms and pedagogical approaches, the idea was to introduce something, allow participants to have an initial reaction, move on to the next topic and then revisit the discussions at the next level in iterations throughout the workshop. One motivation was to allow participants' thoughts to "marinate" before moving forward. Another was to show the interconnectedness, in fact the inseparability, of the various topics.

Significant time at the planning stages was dedicated to choosing language that best represented our goals. What emerged as the three most important values to incorporate into undergraduate courses were critical thinking, socio-technical systems thinking, and developing student agency. Regarding assessment of high-level skills, such as critical thinking, context must be considered in the evaluation. We agreed that DEI was not a tangential part of teaching sustainability, but integral to meeting sustainability goals. In addition, DEI is now a new requirement for learning outcomes at the University. Unfortunately, communicating the inter-dependence of DEI and sustainability can be a challenge.

Workshop organizers were concerned that this should be a special workshop as several of us had attended poorly planned workshops in the past.  An idea of orienting around food took shape, as evidenced by a phrase we agreed upon as a group, "food is an expression of our values."  Building on the spiral approach, we planned the workshop meals and breaks with as much intention as the other curriculum.  Each meal or break was "branded" in a way that highlighted a tension or educational goal.  This helped us communicate to participants that their presence was not taken for granted, that they were guests and we were hosts, and as such we as hosts felt a responsibility to care that their whole workshop experience was transformational.

**Workshop Details and Participant Response**

The pilot workshop was held over 4 days, 5 hours/day, in January 2023.  Participants had been selected for their ability to effect change:  DUGS, associate deans, early adopters, or instructors of large required undergraduate courses.  They were from ME and CEE, as well as from the Keystone program, which is responsible for Engineering-wide 1st and 2nd year courses.  In addition, we had faculty from the Department of Electrical and Computer Engineering (ECE) and from the College of Computer, Mathematical, and Natural Sciences.  The group was limited to 11 people to allow testing of our workshop approach before a wider-scale rollout next year, and they included both tenure track and professional track faculty.  The schedule was packed and included a mix of types of activities:  teambuilding, individual work, group activities, content delivery, demonstrations, and examples of previous implementations by University of Maryland engineering faculty.

Despite the heavy time commitment, faculty returned to the workshop every day.  Their reactions were gathered in a short survey at the end of each day asking about pacing and favorite activities.  Most popular were the examples of what other faculty have done.  The faculty were enthusiastic about the new tools and expressed an interest in introducing them in their courses.  Another popular session brought in STS undergraduate students to give early feedback to the faculty on their plans for course changes.  The participants were also satisfied with the rapid pace and the spiral approach; while there was a lot of information to take in, they found it interesting and appreciated not being bored, and there were fans of all the various components.

**Impact and Future Directions**

An important issue will be continuing and expanding upon the curriculum changes.  The immediate challenge is creating a sustainability teaching community of practice (SCOP), so that we do not lose momentum, which was a concern raised by the participants.  This is envisioned to comprise various channels of communication, meetings focused on what is working or not working (both holding each other accountable for implementing changes and supporting each other in that), individual coaching, and visits to each other's classrooms.

Another challenge will be considering the format and length of future workshops to a more hesitant audience.  One of the lessons learned was that the 4-day format, while it worked well for the initial audience because of the topics they teach, will need to be adapted in future workshops.  For example, introduction to tools such as life cycle assessment (LCA) could potentially be covered separately, and it may be possible to present contextual information, such as economics or the United Nations Sustainable Development Goals (UN SDGs), in seminar-like presentations

for the college.  That would allow shorter workshops focused on course modifications.  Another example would be to build more in-workshop time for faculty participants to mature their implementation of their ideas into their own courses.  The idea is that having that time in-workshop allows faculty participants to use the organizers and other participants as a resource for sharing and for ironing out logistical issues in their ideas.

Assessing the impact of the course changes is another important issue.  At the course level, instructors are implementing trial assessments this semester.  Feedback through the SCOP should lead to refinement of those assessments over time.  Program-level assessments are more challenging.  The workshop organizers have, since Fall 2020, surveyed students every semester in required courses in years 1, 3, and 4, providing a measure of not only students' recognition of their environmental and social responsibilities, but also changes they are actively making for the better [5].  Other assessments of the effectiveness of the multiple touchpoints need to be developed; this is an area ripe for further research.

Given the urgency of preparing students to address global challenges, another critical aspect that must be taken up is sharing discipline-specific lesson plans.  What specifically can be done in a fluid mechanics course, for example?  What are some small, intermediate, or large changes that can be made, and what is their effectiveness?  While some resources are available in various places, building a network to share teaching materials and practices would help to advance this work more widely.

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