

Institutionalizing Sustainability: A Multi-Institutional Study of Engineering for One Planet Integration Strategies

Dr. Lorena S. Grundy, University of Pennsylvania

Lorena is a Practice Assistant Professor at the University of Pennsylvania working in energy and sustainability education, and is the founding director of a new master's degree program in Energy and Sustainability Engineering. She earned her BSE from Princeton in 2017 and PhD from UC Berkeley in 2022, both in chemical engineering, and then studied chemical engineering education with Milo Koretsky at Tufts University as an ASEE postdoctoral fellow from 2022-2024.

Dr. Jennifer Mueller PE P.E., Rose-Hulman Institute of Technology

Dr. Jennifer Mueller is an Associate Professor in the Department of Civil and Environmental Engineering at Rose-Hulman Institute of Technology. She graduated with her BS in Environmental Engineering from Northwestern University and with her MS and PhD in Civil Engineering with an emphasis on Environmental River Mechanics from Colorado State University. Her graduate work focused on exchange of surface water and groundwater, as well as nitrate uptake, in streams with varying degrees of rehabilitation. Dr. Mueller's areas of interest include water quality, sustainable design, watershed hydrology, and river hydraulics. Current projects involve pedagogical studies for incorporating sustainability and ethical decision making in undergraduate engineering education, with an emphasis on touchpoints throughout the four-year curriculum.

Dr. Roneisha Wynette Worthy, Kennesaw State University

Dr. Roneisha Worthy, Ph.D. is currently the Assistant Dean of Student Success within the Southern Polytechnic College of Engineering and Engineering Technology at Kennesaw State University. In addition to her administrative role, she remains actively engaged in teaching and conducts research with a focus on increasing the representation of minorities in Engineering. Before joining the university, Dr. Worthy served as a Research Assistant at Vanderbilt University, contributing to a group funded by the Department of Energy. Her primary research focused on the long-term evaluation of near-surface waste disposal under climate change impacts at nuclear waste sites. With a background as an environmental engineer/planner at Gresham, Smith, and Partners, as well as General Motors Corporation, Dr. Worthy brings a wealth of industry experience to her academic roles. She has a proven track record of addressing critical environmental challenges. In her recent endeavors, Dr. Worthy is actively collaborating with the Lemelson Foundation to institutionalize the Engineering for One Planet framework at Kennesaw State University. This initiative reflects her commitment to sustainability and innovative engineering practices.

Prof. Rodrigo Martinez-Duarte, Clemson University

Rodrigo Martinez-Duarte is an Associate Professor in the Department of Mechanical Engineering at Clemson University (CU) in the US and Head of the Multiscale Manufacturing Laboratory www.multiscalemanufacturing.net. His group's expertise lies at the interface between micro/nanofabrication, carbonaceous materials, electrokinetics and microfluidics. Rodrigo is known as the pioneer of carbon-electrode Dielectrophoresis (carbonDEP), a technique for bioparticle manipulation using carbon electrodes and microfluidics devices with application to diagnostics and therapeutics. He is also internationally known for pushing the envelope on the use of renewable materials and non-traditional techniques such as origami and robocasting to manufacture shaped geometries that serve as precursors to architected carbon and carbide structures. At the nanoscale, his group is innovating ways to use microbial factories as nanoweavers of biofibers. A recurrent theme in his Multiscale Manufacturing Laboratory is assessing the effect of processing on the properties of carbonaceous materials and structures at multiple length scales, towards tailoring their performance. At Clemson University he teaches manufacturing processes and their application, as well as fundamentals of micro/nanofabrication. His pedagogical approach emphasizes teamwork, flipped classrooms, and project-based learning. Besides the US, Rodrigo has lived and worked in Switzerland, Spain, India, Mexico and South Korea and has a track record of service and leadership. Selected current positions

include the Chair of the College of Engineering, Computing and Applied Sciences (CECAS) Committee on Global Engagement, and Guest Editor and an active Reviewer for leading journals in his field. He is also a Past President of the AES Electrophoresis Society and Past Chair of CU Commission on Latino Affairs. He is or has chaired several sessions and international meetings on Carbon and/or Electrokinetics within the Electrochemical Society, Society for Hispanic Professional Engineers and AES. He is the recipient of multiple awards at Clemson University and his professional communities.

Dr. Dustyn Roberts P.E., University of Pennsylvania

Dustyn Roberts is a Practice Associate Professor at the University of Pennsylvania. She received her BS in Mechanical and Biomedical Engineering from Carnegie Mellon University, her MS in Biomechanics & Movement Science from the University of Delaware, and her PhD in Mechanical Engineering from New York University.

Dr. Medha Dalal, Arizona State University

Medha Dalal, Ph.D., is an Associate Director of Scholarly Initiatives and Assistant Research Professor of Engineering Education Systems & Design within the Ira A. Fulton Schools of Engineering at Arizona State University. Her career as an engineering educator and researcher focuses on addressing complex engineering education challenges by building capacity for stakeholders at the grassroots, while also informing policy. Her research seeks to transform and democratize engineering education by exploring ways of thinking, identifying effective professional development approaches, and uncovering pedagogical techniques that enhance students' engineering curiosity, engagement, and learning.

Victoria Minerva, Villanova University

Victoria Minerva is the Director of the Sustainable Enterprise Executive Education & Development (SEED) program at Villanova University's College of Engineering. She leads professional development initiatives such as empowering engineering faculty to integrate sustainability into curricula, drawing on the Engineering for One Planet (EOP) framework. Victoria co-facilitates EOP Faculty Development workshops through sponsored research work with the Lemelson Foundation and she collaborates with academic and industry partners through the RISE Forum to advance sustainability education. Her work focuses on cultivating systems thinking and interdisciplinary approaches to sustainable engineering practice and pedagogy.

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Introduction and Background

This work-in-progress study investigates the institutionalization of the Engineering for One Planet (EOP) framework across diverse higher education institutions. The EOP framework is a compilation of research-based student learning outcomes that span nine topic areas necessary to equip students to enact social and environmental engineering solutions [1]. While the EOP initiative offers a compelling vision for embedding sustainability into engineering education, its successful implementation depends on faculty navigating complex organizational ecosystems. Our project aims to identify how institutional structures, cultures, and leadership models can influence the adoption and integration of EOP principles.

There are many ways to approach an institutional change effort like the institutionalization of the EOP framework within higher education. Henderson et al. [2] identify two important characteristics of institutional change efforts. First, efforts may target change in individual behavior or wider systems; in this study, we argue that in order to help individuals adopt the EOP framework in their courses or programs, change efforts must be tailored to the systems in which they work. The initial step in designing such an institutionalization effort is thus to understand the diversity of the targeted systems. Second, outcomes may be set in advance or may be shaped by the participants in the institution. While our aim is for the EOP framework to be used across institutions, its implementation is inherently flexible and adaptable to different contexts. Our goal is to learn from instructors and leaders at different institutions about how the framework aligns with their education goals, so that in the next phase of work, we can design implementation strategies that support instruction in different course subjects and contexts, and of different student populations.

Grounded in organizational change theory, we conduct semi-structured interviews with faculty and administrators from a range of institutions selected to represent different contexts, including geographical location, research activity classification, size, and other factors. In this starting phase, we primarily focus on faculty and administrators who work with engineering students and who do not significantly incorporate sustainability topics in their coursework. The study is designed to identify barriers, enablers, and strategies for embedding sustainability into engineering curricula. Here, we outline our interview protocol and analysis methodology. By the time we submit the final paper, we plan to include preliminary analysis from pilot interviews, along with insights into institutional readiness and alignment with EOP core learning outcomes. In future stages, the study outcomes will inform a supplement to an existing EOP institutionalization guide [3] and support other institutions in adapting the framework to their unique contexts.

Methods

This study is grounded in the recognition, articulated by Henderson et al. [2], that sustained instructional change in STEM education requires attention to the broader organizational systems in which faculty work, rather than focusing solely on individual behavior. An initial phase of our multi-methods approach is to conduct semi-structured interviews with faculty and administrators from a range of institutions. The institutions in this study, the key characteristics of which are given in Table 1, range from public R1 to private teaching-focused institutions with student populations ranging from 2,300 to 50,000, including Ivy League and Land Grant institutions.

Table 1. Characteristics of Initial Interview Sites

Institution Name	State	Carnegie Classification	Type	Total Students
University of Pennsylvania (Penn)	PA	R1	Private	29,000+
Clemson University	SC	R1	Public Land-Grant	29,000+
Arizona State University (ASU)	AZ	R1	Public	190,000+
Kennesaw State University (KSU)	GA	R2	Public	50,000+
Rose Hulman Institute of Technology (RHIT)	IN	Special Focus: Technology, Engineering, and Sciences	Private	2,300+

To better understand barriers to integrating sustainability principles through the EOP framework, we developed an interview protocol that includes common target interviewees across institutions and a set of shared questions for collecting interviewee perceptions through their responses. These interviews provide insight into barriers across institutions and how variation in institutional structures can impact readiness for curricular integration of sustainability principles through the EOP framework.

Target interviewees include faculty and administrators who work with engineering students and who do not significantly incorporate sustainability topics in their coursework. Faculty can be in an engineering discipline or any other discipline, as long as they teach engineering students. The interviews are semi-structured, and the specific questions therefore vary. However, a sample question set is given in Appendix A. Initial questions provide framing and context for interpreting responses based on the interviewee's role at their institute and career level. Further questions address courses taught, as well as the year and major disciplines of engineering

students in their courses; how they define sustainability and if it's perceived as important to engineering; and any intentional inclusion of sustainability in courses and awareness of the EOP framework.

Pilot interviews have been conducted at participating institutions, with nine interviews completed thus far: 1 at Penn, 1 at Clemson, 2 at ASU, 2 at KSU, and 3 at RHIT. In this work, we report initial themes from the interviews. In the future, differences will be categorized by institution characteristics to identify common responses among similarly structured institutions.

Institutional Review Boards at each institution determined that the study activities were exempt under the following IRB identification numbers: Penn (45393766), Clemson (IRB2025-1630), ASU (STUDY00023553), Kennesaw State (IRB-FY26-302), and RHIT (RHS0447).

Results

Initial interviews indicate emergence of several key themes. We present these initial findings while noting that they are based on a small sample of nine pilot interviews, and may shift with further data. Expansion of interviews will allow more detailed analysis of the relationship between themes and institution characteristics.

Theme 1. Motivation and Incentives

Interviewee 1 from ASU has not incorporated sustainability into their teaching. When asked why, they described having a lack of personal motivation to engage with the topic: "I'm not intrinsically motivated to seek out sustainability interventions." Thus, they explained, the impetus for change would have to be external: "if our dean said, 'hey, everybody is to assess some new sustainability learning outcome,' I would say, 'okay, well, if my boss is telling me I have to do it, I've got to figure out a way to do it.'" For Interviewee 1 from Clemson, who does incorporate the EOP framework in their teaching, an extrinsic motivation came in the form of industry demand for solutions that are not only economical but also "makes sense for the planet and for the people."

Interviewee 1 from ASU described another possible extrinsic motivation: "if the right dollar amount extrinsically were presented to me, I mean, sure." Interviewee 2 from RHIT described a financial incentive from a different lens: they are motivated to incorporate sustainability, but "definitely time [is the] biggest thing... it's not possible during the school year." Thus, when there are "funds from the department" to offer paid time over the summer to work on curriculum development, "that's very, very, very helpful." Funding would also help Interviewee 2 from KSU: "You know, it takes a long time... unfortunately I don't get any help."

Several other interviewees described intrinsic motivation to integrate sustainability into their teaching. For example, Interviewee 1 from KSU thinks about sustainability because "we are trying to design solutions... for society, for civilization," and Interviewee 1 from Penn hopes to help students "to think about how are we best stewarding the resources that we have available."

However, for some tenure-track faculty like Interviewee 1 from Penn, intrinsic motivation is tempered by extrinsic pressures: “it's extremely time-consuming [to modify courses], and there's pressure to do less of that, because I need to get my research program up and running.”

Theme 2. Accessibility of Resources

Several interviewees who expressed intrinsic motivation to incorporate sustainability simply lacked the tools or resources to do so.

Interviewee 1 from RHIT, for example, teaches math courses targeted at engineers, and while they believe sustainability is “really relevant,” they have not incorporated it into their teaching “only because I don't know how it would fit into the math, you know, into the mathematical curriculum.” Instead of external motivation, what they would need to overcome their barrier would be guidance and teaching tools: “Is there a different lens that we could use to deliver the content of [math course] that is like a sustainability lens? ... Yeah, absolutely. And if that could be focused for me, then I would certainly use it.”

Interviewee 1 from KSU, despite caring about teaching sustainability skills to their students, has not incorporated it, largely due to inexperience and lack of comfort: if someone else were to propose an idea, “I think it would be awesome. I would be more prone to try to grab and run with or incorporate their ideas than think of the ideas or the connections on my own.”

Given the lack of funding for additional support and the finite availability of time, faculty like Interviewee 3 at RHIT rely on accessibility and availability of online resources: “Funding would be helpful, but given where we are, funding doesn't usually come around. So what I usually rely upon is... resources that are available online.”

Theme 3. Academic Freedom and Control of Curriculum

Another barrier was identified by Interviewee 2 from ASU, who teaches a large course with “like 30 different sections” every semester. Because of the need for coordination across sections, “there is a curriculum that is already... defined and then it's our... job to [determine] ‘okay, this is what is going to happen to fulfill those goals and objectives.’” Given the pre-determined curriculum, this instructor does not have the academic freedom to shift the course content to integrate sustainability without a more coordinated change to the curriculum.

This highlights a potential difference between institution types. ASU is a large, public land-grant institution, while RHIT is private and almost two orders of magnitude smaller. Asked about their curriculum change process, Interviewee 1 from RHIT said, “we're not super coordinated... that's kind of completely up to us.” Hence, with sufficient guidance, they would be able to choose to integrate sustainability into their course.

Discussion and Conclusion

In the context of institutionalizing the EOP framework, the literature suggests that faculty adoption of sustainability-oriented practices is shaped by factors such as disciplinary norms, accreditation pressures, reward structures, and available instructional support. As such, successful EOP integration will depend not only on faculty interest or awareness, but also on how well the framework aligns with existing institutional priorities and decision-making processes. Indeed, most interviewees were aware of sustainability and believed it to be important to include in their teaching, but lacked the time, resources, or academic freedom to modify their courses accordingly.

This work-in-progress study positions the institutionalization of the EOP framework as an organizational change challenge rather than an individual instructional choice. For example, for faculty who do not have the decision-making power to restructure their course content, providing resources like assignments and activities will not lead to increased integration of sustainability into teaching. Other faculty are aware of ways in which they could improve their teaching, including materials they would like to incorporate, but simply lack the time or institutional incentive to make the changes. Drawing on frameworks and existing literature, the study is designed to surface how institutional context, faculty decision-making processes, and structural supports shape readiness for sustainability integration in engineering education. This will inform future iterations of the EOP framework itself, and its accompanying resources.

Acknowledgements

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References

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Appendix A. Sample Interview Questions

After the initial framing questions for the conversation, the following questions are examples of topics included in the semi-structured interviews.

- 1) What is your typical course curriculum development process?
- 2) How often do you make changes in your coursework (i.e. learning objectives, in-class activities, course projects or assignments)?
- 3) How do you choose what to include and not include in your courses? Do you base this on accreditation requirements, FE topics, discipline-specific BOKs, personal interest, practitioner input on relevance in industry?
- 4) What resources do you typically require when making changes to your coursework (funding, student support, teaching and learning support, technology tools, topical material resources, etc.)?
- 5) What has helped you to incorporate changes in your courses (e.g. time to develop course changes, other incentives, etc.)?
- 6) What has hindered you from incorporating changes in your courses (e.g. lack of time to develop course changes, lack of other incentives, etc.)?
- 7) Do you support initiatives for curricular integration of sustainability?
- 8) What kinds of sustainability-related skills do you think are important for engineering students to learn? What would you like them to understand or be able to do, if anything?
- 9) Do you feel it is important for your students, as future engineers, to understand the impact (environmental, social, and economic) their designs can have on the world?
- 10) Why are you currently not integrating sustainability in your course(s)?
- 11) Is there anything you have been wanting to implement related to sustainability in your education work, but haven't? Why not?
- 12) What would help you integrate sustainability in your course(s)?
- 13) What challenges have you encountered that prevent or discourage you from integrating sustainability into your course(s)?
- 14) For multi-section courses, is sustainability integrated in just one and not all sections? If so, why not incorporate it in all sections of a course?
- 15) Are there any non-coursework initiatives that you are part of in the sustainability space? Are there any that you would like to be involved in? What are the barriers?