

Work-in-Progress: Investigating the Broader Impact of Faculty Development Practices for Integrating Sustainability into Higher Education Engineering Curriculum

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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.

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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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Abstract

Advancing higher education for sustainability is integral to prepare future engineers for the complex, global challenges they will face in practice. As many engineering faculty do not have specialized degrees in sustainability, sustainable engineering design, or sustainable development, it is essential to provide professional development. Several institutions of higher learning have developed faculty workshops, networks, and communities of practice to provide participating faculty support to advance the design and delivery of sustainability content in curricula across engineering disciplines. These faculty development opportunities align with resources and learning outcomes established through the Engineering for One Planet framework and UN Sustainable Development Goals.

Through this work-in-progress, mixed-methods study, we are investigating professional practices of faculty several months to five years after completion of faculty development workshops and networks administered at four different institutions of higher learning across the US. As these institutions represent a range of size and demographics, we aspire to attain a broader perspective of best practices, benefits to faculty by providing these professional development opportunities, and impacts beyond curriculum integration of sustainability. By collecting survey data from faculty participants, we are assessing short-term and long-term workshop impacts, and exploring how adopting sustainability into curricular aspects of their work leads to sustainability influences in other activities of faculty professional and personal development. Early findings from initial survey results show that participants valued the community aspect of peer-to-peer learning they experienced through the faculty development initiatives. The planned activities for curricular integration facilitated through the faculty development initiatives were successful and further sustainability integration occurred in other courses taught by faculty participants.

Introduction

Through this multi-institute study, we are investigating the impact of faculty development initiatives to promote sustainability in engineering education by reviewing participant feedback immediately after completion of the faculty development initiatives and conducting surveys and interviews of participants several months to five years after completion. Faculty development initiatives were conducted at four different institutions from 2021-2025 and range from summer faculty training through communities of practice (CoP), week-long workshops, and a combination of a workshop followed by CoP meetings.

Leaders of the faculty development initiatives from the four different institutions connected through the Engineering for One Planet (EOP) network of engineers, educators, and

sustainability professionals. Upon recognizing we were conducting similarly aligned faculty development initiatives for integrating sustainability at our home institutions, the leaders from each institution collaborated to compare findings and conduct future studies to assess the impact of these initiatives on expanding sustainability in engineering curriculum and on professional growth of participants. Several of these faculty development initiatives have led to opportunities for peer mentoring, where invested faculty can continue to contribute to the development initiatives after completing the workshop or initial CoP. Initiatives, such as these, are essential to provide empowerment and skill development for faculty to successfully integrate sustainability in engineering education [1]. The development initiatives provide faculty with support and dedicated time to develop sustainability content within a discipline-specific course of their choosing.

Utilizing the EOP framework as a guiding platform provides a central resource for integrating sustainability in engineering education. The EOP framework covers sustainability-focused student learning outcomes in the following nine topic areas: systems thinking, environmental literacy, responsible business and economy, social responsibility, environmental impact assessment, materials, design, critical thinking, and communication and teamwork (Figure 1) [2]. Learning outcomes within each area are denoted when directly tied to ABET criteria [3] or a United Nations Sustainable Development Goal (UN SDG) [4]. The framework provides a practical means for making curricular changes that are core to building knowledge, behaviors, and skills needed for engineers to have a positive impact in our world [2].



Figure 1: Engineering for One Planet (EOP) Framework – a pedagogical tool for integrating sustainability into engineering curriculum [2]

Methods

This study is designed to address the following research questions:

1. What are the transferable and scalable effective practices from faculty development initiatives that promote sustainability integration in engineering education?
2. What broader impact do these faculty development initiatives have on continued professional growth of participants?

The first phase of our work-in-progress, mixed-methods study was to survey past participants who have completed EOP or sustainability faculty development initiatives at four different institutions of higher education: Arizona State University, Kennesaw State University, Rose-Hulman Institute of Technology, and Villanova University. The spectrum of institutional

characteristics in this study ranges from public R1 to private teaching-focused institutions with student populations ranging from 2,300 to 50,000 across varying geographic regions in the US.

The survey included both closed-ended and open-ended questions and was distributed via SurveyMonkey to 79 faculty. Data was collected, and personal identifiable information was removed by a third party before the responses were given to researchers for review.

Ratings for the closed-ended survey questions were based on a 5-point Likert scale (1=Strongly Disagree, 2=Disagree, 3=Neither Agree nor Disagree, 4=Agree, and 5=Strongly Agree). Participants submitted ratings to the following statements in the survey.

1. After completing the workshop, I integrated my planned course activity.
2. The integrated course activity went well, and I have maintained this in subsequent course offerings.
3. I have incorporated sustainability principles into other courses I teach.
4. I participated in post-workshop follow-up engagements offered by the workshop organizers.
5. Post-workshop follow-up engagements helped foster the integration of sustainability in my courses.
6. I have integrated sustainability principles into other areas of my professional development activities.
7. I have integrated sustainability principles into other areas of my service activities.
8. The workshop led to a mindset shift by approaching my existing professional activities (e.g. research, course development, mentoring student projects, educational outreach, etc.) through a broader, systems perspective to address sustainability.

Demographic information was collected to differentiate host institutions and academic roles represented. The following open-ended questions were also included as required responses in the survey.

9. How was what you learned in the workshop initially incorporated into your courses? If it was not, why?
10. Has this changed since the first iteration? If so, how?
11. Does what you incorporated cover environmental, social, and economic topics?
12. What was done through the workshop to improve faculty buy-in and confidence in incorporating sustainability into existing courses/programs?
13. Since completing the workshop, have you incorporated sustainability principles and practices into other areas of your work besides teaching/coursework, such as research, community outreach, campus social programs? If so, how?
14. Please describe any other insights or reflections you'd like to share about your experience of participating in the workshop and how it has impacted your professional and/or personal development.

Results

With a response rate of 43%, 34 participants responded to the close-ended survey questions Q1-Q8. Participants represented a variety of engineering disciplines, including biomedical, chemical, civil and environmental, computer, and mechanical engineering. Responses represented all four participating institutions well and covered a distribution of career levels (Figure 2).

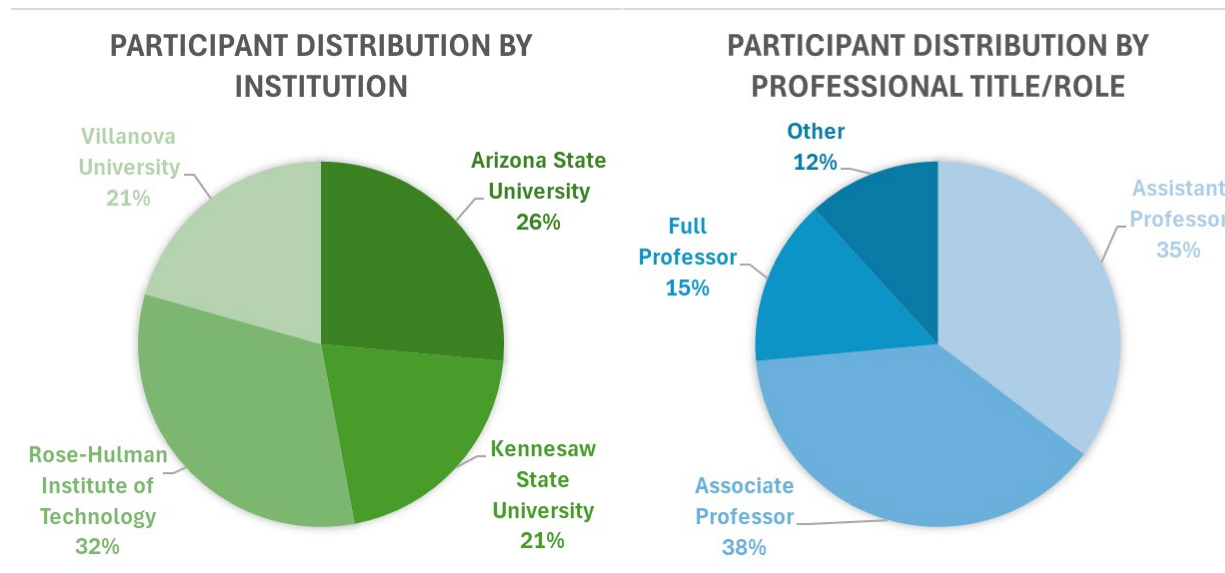


Figure 2: Distribution of survey participants by institution and professional title/role (n=34)

Findings from survey data (Figure 3) show that all faculty participants did integrate their planned course activity from the faculty development initiative with over half agreeing that the integrated activity went well. Slightly over half of survey respondents agreed that they incorporated sustainability principles into other courses beyond what was planned through the faculty development initiative. Over half of survey respondents noted that they participated in follow-up engagements, but less than half agreed these helped foster sustainability integration. Nearly all respondents agreed that they have integrated sustainability into other professional development activities with just over half agreeing they have integrated sustainability into service activities. Slightly over half agreed that the faculty development initiative led to a mindset shift for expanding sustainability and systems thinking into other areas of their professional growth.

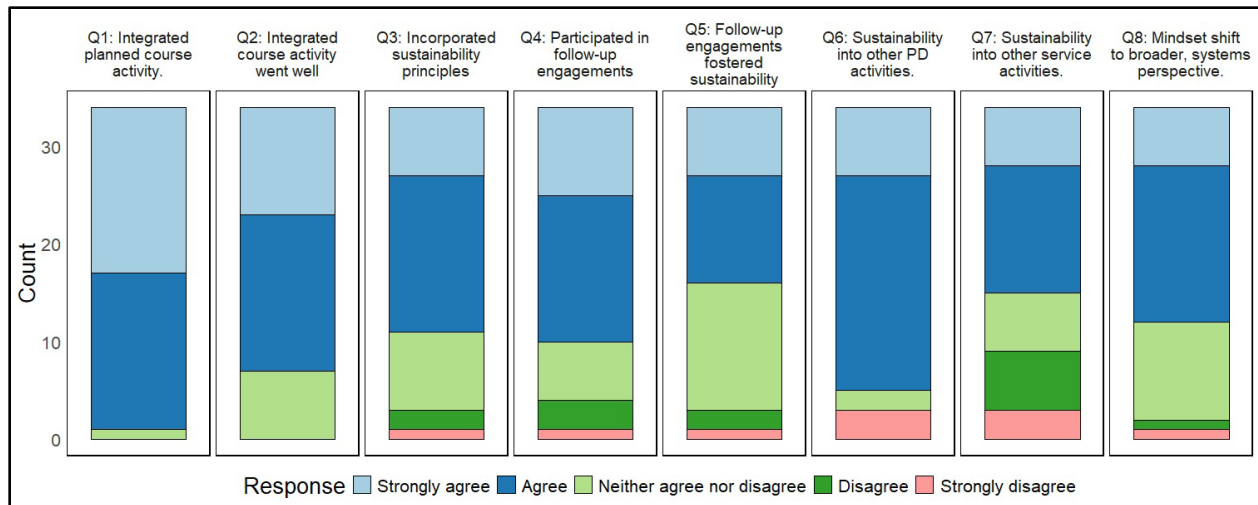


Figure 3: Responses of ratings for closed-ended survey questions Q1-Q8 (n=34)

Using a reflexive thematic analysis approach [5], themes of enabling infrastructure, patterns of curricular integration, sustainability framing spectrum, and professional and institutional spillover emerged when coding the short answer responses in questions Q9-Q14 (Table 1). We have received 33 responses but the results below are based on the 19 responses that were received in time for the analysis and reporting.

Participants of faculty development initiatives who responded to the survey noted that community, collaboration, and peer-to-peer learning were effective features of the initiatives across all institutions. Faculty also noted examples of curricular integration are helpful tools for incorporating sustainability through the EOP framework in their courses. Collective results also show that faculty development initiatives led to sustainability integration in other courses and professional growth activities.

Table 1: Emergent themes from responses to survey questions Q9-Q14 (n=19)

Theme	Definition	Analytic Focus	Exclusion Notes	Quotes	Primary Questions
Enabling Infrastructure	Captures the structural and relational supports that made sustainability integration feel feasible and actionable. Includes tools, modeled examples, structured activities, and collaborative community that reduced uncertainty and increases confidence.	What made change possible?	These are not what changed in the course.	“Provided practical tools and templates.” (P2) “Shared examples from peers.” (P1) “Built a supportive environment.” (P7) “Provided confidence through examples.” (P19)	Q12, Q14
Patterns of Curricular Integration	Describes the degree and form of structural modification faculty made to incorporate sustainability. This ranges from assignment-level changes to complete course redesign.	What was changed?	These are not how sustainability as a concept was addressed.	“Added homework questions related to sustainable design” (P4) “Modified the final term project to include sustainability components.” (P16) “Created three sustainability-oriented projects focusing on ecological impacts.” (P8) “Developed an entirely new course centered around the UN SDGs.” (P17)	Q9, Q10, Q14
Sustainability Framing Spectrum	Reflects the breadth of sustainability conceptualization within courses. This ranges from environmental-only approaches to dual and triple pillar integration. May suggest how faculty interpreted sustainability independent of structural changes they made in their class.	How did faculty translate/frame/conceptualize sustainability into their course?	This is independent of how much and what was changed.	“Mostly environmental.” (P1) “Environmental and social.” (P2) “All three to some extent.” (P3) “Yes, fully integrated across all three.” (P17)	Q11, Q14
Professional and Institutional Spillover	Captures the extension of sustainability integration beyond coursework into research, outreach, service, and professional identity formation. Reflects broader scholarly and institutional impact.	What happened beyond the classroom?	This does not exemplify personal spillover and is only referring to professional features.	“Yes, incorporated into research.” (P1) “Integrated into grant proposals.” (P5) “Yes, advisory roles.” (P9) “Expanded professional focus.” (P16)	Q13, Q14

Discussion and Conclusion

Early findings from initial survey results show that participants valued the community aspect of peer-to-peer learning they experienced through the faculty development initiatives. The planned activities for curricular integration facilitated through the faculty development initiatives were successful and further sustainability integration occurred in other courses taught by faculty participants. Follow-up engagements may not have been as influential in faculty participants' curricular integration of sustainability.

This work is relevant to engineering education, more broadly, as findings lend to effective practices for faculty development initiatives. As sustainability and sustainable design considerations are inherent to the work of environmental engineers, the need for engineering educators to integrate sustainability is essential, and this study explores effective approaches to help faculty with this integration.

Through this study, we are not investigating differences in pedagogical approaches for curricular integration of sustainability, but rather we are investigating effectiveness of faculty development approaches for integrating sustainability into curriculum. By assessing impacts across different institutions, we can coalesce effective faculty development practices that are transferrable for implementation at other institutions, as well as noting differentiating factors that vary in effectiveness across institutions.

Future work will involve conducting interviews to explore specific survey findings in greater depth, allowing for a more comprehensive understanding of the results. We will then compare and contrast design features of the faculty development initiatives across institutions with survey responses and interview feedback to inform effective practices for continued integration of sustainability in curriculum and for opportunities to expand sustainability applications in other areas of professional growth, noting what aspects of the faculty development initiatives were effective for curricular integration of sustainability. By comparing practices across institutions, we can determine what features of our workshops and networks are most influential to faculty.

Through this work, we are investigating if participation in curricular workshops has led to sustainability-focused research or other professional activities, as well as if participation has enhanced a systems approach in existing research programs. By establishing communities of educators, we are creating supportive environments for sharing and growth to increase the diversity of perspectives and backgrounds around sustainability, to broaden touchpoints of sustainability throughout engineering curriculum, and to expand growth in sustainability applications that branches out to other professional activities.

References

- [1] Segalas, J. & Tejedor, G. 2025. "Faculty Empowerment in the Sustainability Education Transition." *The Routledge Handbook of Global Sustainability Education and Thinking for the 21st Century*. Michele John (ed.) Abingdon: Oxford UP. 452-462.
- [2] The Lemelson Foundation. 2026. The Engineering for One Planet Framework: Foundational Learning Outcomes to Prepare Engineers to Protect and Improve Earth and the Life it Sustains. Cynthia Anderson and Cindy Cooper (Eds). The Lemelson Foundation, Portland, Oregon. USA.
- [3] ABET. 2021. Criteria for Accrediting Engineering Programs, 2022-2023. <https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2022-2023/>.
- [4] United Nations Sustainable Development Goals. 2015. Transforming Our World: The 2030 Agenda for Sustainable Development. <https://sdgs.un.org/publications/transforming-our-world-2030-agenda-sustainable-development-1798>.
- [5] Braun, V. & Clarke, V. 2022. Thematic Analysis: A Practical Guide. Sage.