

Strengthening the Impact of Student Leaders in National Science Foundation Engineering Research Centers

Dr. Denise M. Driscoll, Purdue – West Lafayette

Dr. Denise M. Driscoll is Director of Access and Societal Impacts for the National Science Foundation Engineering Research Center for Innovative and Strategic Transformation of Alkane Resources that is housed in the Charles D. Davidson School of Chemical Engineering at Purdue University. She is also an Adjunct Assistant Professor of Psychological Sciences in the College of Health and Human Sciences at Purdue University.

Dr. Jean S Larson, Arizona State University

Jean S. Larson, Ph.D., is an Associate Director of Instructional Effectiveness and Innovation in the Learning and Teaching Hub and a Research Associate Professor in the School of Sustainable Engineering and the Built Environment, both in the Ira A. Fulton Schools of Engineering at Arizona State University. She has a Ph.D. in Educational Technology, postgraduate training in Computer Systems Engineering, and many years of experience teaching and developing curriculum across a variety of learning environments. She has extensive experience teaching K-12 students locally and internationally, educating pre-service teachers and faculty at Arizona State University to integrate technology into their teaching, and delivering professional development workshops for business and industry. Dr. Larson is experienced in the application of instructional design, delivery, and evaluation, and specializes in eLearning technologies for training and development. Her research focuses on pedagogical innovation, curriculum and program development, evaluation, interdisciplinary collaboration, and strengthening the global workforce through engineering-related education and training.

Kristin M. Everett, Everett Evaluation

Dr. Kristin Everett is the owner and principal evaluator at Everett Evaluation, LLC. Dr. Everett provides STEM program evaluation services for universities and other nonprofit organizations.

Maeve Drummond Oakes, Purdue University – West Lafayette (College of Engineering)

Maeve Drummond Oakes is the Director of Engineering Workforce Development for CISTAR, an NSF ERC. She leads the design and implementation of innovative education, training, and outreach initiatives that prepare a future-ready engineering workforce with expanded access and opportunity aligned with CISTAR's mission. She oversees integrated programs spanning K-12 engagement, undergraduate and graduate education, industry internships, and professional skill development, ensuring that students and trainees gain the technical expertise, entrepreneurial mindset, and leadership capabilities needed to translate research into real-world impact. She has extensive experience in academic program management at Purdue University, having successfully led undergraduate and graduate programs in the School of Civil Engineering. In Biomedical Engineering, she led the development of new experiential activities for students through industry partnerships and study abroad. As the university coordinator for the Purdue EPICS program, she was responsible for developing a consortium of more than 40 universities worldwide.

Theresa Chatman, Rice University

Eva Deemer, University of Texas Health Science Center

Katherine Michelle Currier, Arizona State University

Strengthening the Impact of Student Leaders in National Science Foundation Engineering Research Centers

Abstract

This evidence-based practice paper describes the design and impact of a national convening aimed at addressing leadership challenges among graduate student leaders within National Science Foundation (NSF) Engineering Research Centers (ERCs). The overarching goal of the convening was to foster leadership skills, collaboration, shared learning, and a sense of community within graduate student leaders from across the ERCs. Developing graduate student leadership is critical for both individual professional growth and the long-term success of ERCs. While Student Leadership Councils (SLCs), mandated by the NSF ERC Program, provide leadership opportunities, graduate student leaders often face challenges related to leadership turnover and limited opportunities for cross-center learning. To address these gaps, twenty-four graduate student leaders from 14 ERCs were convened for a 2-day ERC Meeting for Graduate Student Leaders in March of 2025. The meeting built on a prior 2024 ERC Conference for Leaders that included both education and graduate student leaders. These two convenings were supported through NSF funding to the Center for Innovative and Strategic Transformation of Alkane Resources (CISTAR). At the 2025 graduate student-only meeting, the goals were to: 1. strengthen personal and professional connections, 2. foster a collaborative community for sharing best practices and forging collaborations, and 3. establish sustainable structures to support leadership continuity. Most of the participants were SLC representatives with roles such as president/chair, vice president/co-chair, professional development liaison, or industry liaison. The design of the meeting was based on lessons learned from the earlier conference that demonstrated: 1. the value of a facilitated discussion approach to enhance engagement and collaboration and 2. the importance of cultivating an environment of connection and trust. Four ERC education directors and a former ERC graduate student leader planned the meeting. A second ERC-savvy graduate student was added to help implement the facilitator discussion approach. To address the importance of a conducive environment, the meeting was deliberately held at the same venue to leverage the familiar trust-building setting among participants of the previous conference. Results confirmed that the event provided a highly conducive environment for learning, engagement, and collaboration. Assessment results (100% response rate) indicated a highly effective meeting experience. Participants were pleased with the conference logistics and session format, with 96% of participants rating the facilitated discussion approach as “excellent” or “very good.” Further, all of the sessions were rated by the majority of participants as “very useful” or “useful.” Newer leaders reported the greatest benefits, though all participants emphasized gains in networking, confidence, and cross-center collaboration. Participants developed concrete follow-up plans, including creating ongoing communication channels and shared professional initiatives. Graduate leaders described the conference experience as “invaluable” and “transformative” and emphasized how it positively impacted them personally and professionally to have forged this new community of SLC/graduate student leaders. There was also widespread appreciation for how this meeting would have long-lasting, broader benefits for their ERC. Findings support the institutionalization of an annual convening to sustain collaboration, strengthen leadership capacity, and enhance the long-term impact of graduate student leadership via the SLC across the NSF ERCs.

Introduction

The National Science Foundation's Engineering Research Center (NSF's ERC) Program is considered one of its most impactful long-running initiatives, having advanced U.S leadership in science and engineering for more than four decades [1]. By creating centers that coalesce experts in research and practice from different fields and types of workplaces, ERCs create environments that amplify innovation and accelerate the translation of research into societal and technological impact.

Beyond technical innovations, ERCs have been charged with preparing the future STEM workforce. This mandate extends beyond disciplinary expertise to include the development of professional competencies such as communication, management, and leadership skills [1, 2]. To support this goal, ERCs employ education experts who design and implement educational and professional development opportunities spanning K-12 engagement through graduate education.

In the mid-1990s, NSF further strengthened the student leadership mandate of ERCs by requiring the establishment of a Student Leadership Council (SLC) within each ERC. The SLC structure was designed to particularly elevate graduate student voices within ERC leadership and to ensure representation from each participating academic institution. While specific roles and organizational structures vary across ERCs, SLCs typically include positions such as a chair or president (one-year term), a co-chair/vice president (becomes chair/president the following year), an industry liaison, an outreach coordinator, and a professional development coordinator.

NSF assigns SLCs several critical responsibilities, including onboarding new students, planning center-wide student activities, and supporting ERC workforce development goals in coordination with the centers' education directors. SLCs are also required to prepare an annual SWOT analysis report for NSF, as well as meet with the NSF review committee to discuss their report on how the center is doing in meeting the needs of its students.

Despite the importance of these responsibilities, many SLC leaders enter their roles with limited prior leadership experience and minimal opportunities for structured mentoring. Frequent leadership turnover, coupled with variability in ERC-level educational support, further constrains continuity and institutional knowledge transfer. Further, opportunities for cross-ERC interaction among SLC leaders have historically been limited, resulting in few mechanisms for shared learning, peer mentoring, or dissemination of best practices.

This paper describes the design, implementation, and outcomes of a targeted intervention aimed at addressing these preparedness gaps: a facilitated, in-person leadership meeting for graduate student SLC leaders in ERCs across the U.S. Building on lessons learned from prior ERC conferences, the meeting was intentionally structured to promote community building, peer mentoring, and cross-center knowledge exchange. The following sections situate this effort within prior work, describe the pedagogical and facilitation framework guiding the meeting design, and present evidence of its impact on SLC leaders' capacity, confidence, and connectedness across ERCs.

Background and Prior Work

Historically, opportunities for structured cross-ERC learning and community building among SLC leaders have been limited. One notable exception is the ERC Biennial Meeting, re-initiated in 2017, which brings together center leadership every other year. While the NSF ERC Biennial Meeting includes graduate student participation, its format has increasingly emphasized the Perfect Pitch Competition with little time to have meaningful conversations, peer mentoring, or leadership development focused specifically on SLC roles.

Graduate students were also included in two prior leadership-oriented educational conferences, one held in person in 2019 and another held virtually in 2020 due to the COVID-19 pandemic. Consistent with research comparing in person versus virtual impact [3 - 7], participants in the in-person conference reported high satisfaction and meaningful sharing of best practices, whereas the virtual conference was perceived as useful for information exchange but less effective for community building and in-depth discussion.

As a result, since 2019, many SLC leaders have assumed their role with minimal preparation, limited peer support, and few opportunities to learn from leaders in other ERCs. Leadership turnover further exacerbates these challenges, as institutional knowledge is frequently lost during transitions. These conditions highlight a persistent gap in providing timely professional development and mentoring for graduate student leaders within ERCs.

Early in 2023, educational experts in several ERCs that led virtual monthly meetings across ERCs were aware of this gap in developing SLC graduate student leaders as well as leaders serving as education directors. Through a proposal submitted by the Center for Innovative and Strategic Transformation of Alkane Resources (CISTAR) on behalf of the organizing committee, funding from NSF was given to support a 2024 ERC Conference for Leaders. The conference was intentionally designed to support community building, mentoring, and knowledge sharing among education and student leaders across centers. After the success of this first conference [8], there were some funds to follow-up and continue to provide leadership growth and community-building opportunities to SLC leaders, as well as establish sustainable structures to mentor and provide resources to new leaders.

Pedagogical and Facilitation Framework

The ERC Meeting for Graduate Student Leaders was grounded in a facilitated discussion model designed to promote active engagement, shared problem-solving, and peer learning. Prior research across a range of settings has demonstrated that facilitated sessions are associated with stronger participant engagement, greater transfer of learning to practice, and increased collaboration compared to lecture-based formats [9].

The two main facilitators of this meeting were selected based on their familiarity with ERC structures and graduate student leadership roles. Their approach emphasized guiding discussion while respecting the expertise participants brought from their own centers. Active learning strategies, small-group discussions, and reflective activities were used throughout the meeting to encourage participation and knowledge construction [10].

The physical environment was also intentionally selected to support community formation. Holding the meeting in a single, familiar venue enabled informal interactions during meals and breaks, reduced logistical stress [11], and supported sustained engagement over multiple days. Prior work suggests that such environments can meaningfully contribute to trust-building and mentoring relationships [12].

Conference Implementation and Design

The meeting took place only a few minutes from the Chicago International Airport at the Embassy Suites by Hilton Chicago O'Hare Rosemont on March 27-29, 2025. It was well attended with 24 graduate student participants serving in formal SLC leadership roles, representing multiple ERC generations and institutions. There were five participants from three Gen-3 ERCs (established 2008-2017) and 19 participants from 11 Gen-4 ERCs (established 2018 or later). Two facilitators led the sessions, while the other conference organizers ensured the meeting ran smoothly but were not present in the room, allowing the students to freely talk among themselves.

Meeting goals included fostering peer mentoring, building a collaborative cross-ERC community, sharing best practices, reducing redundancy across SLC efforts, and strengthening continuity amid leadership turnovers. The agenda combined structured facilitated sessions with informal networking opportunities over the course of three days. Key design elements included ice-breaking activities, breakout discussions organized by SLC role, exploration of different SLC organizational structures, guided SWOT discussions, and sessions focused on industry engagement and action planning. Participants also established shared communication channels to support continued collaboration following the meeting.

Assessment Methods and Findings

Conference outcomes were assessed using a multi-method approach that included a survey created by the conference organizers and an external evaluator, Everett Evaluation Research & Consulting, as well as analysis of written responses by the two facilitators via email to some questions. The external evaluator administered the survey, providing a link and QR code to participants toward the end of the meeting, and then wrote a report for NSF based on the survey findings. Survey items assessed student participants' perceptions of conference quality, usefulness of sessions, community building, networking and intentions to implement best practices or collaborate in the future.

All 24 participants completed the survey while still at the conference, yielding a 100% response rate. Quantitative data were analyzed descriptively, while qualitative open-ended responses were thematically reviewed to identify recurring patterns related to perceived value, learning, and anticipated impact.

Conference logistics. Overall ratings indicate that participants were highly pleased with the conference logistics and session format. No participant made any rating lower than "Good;" most rated the logistics as "Very Good" or "Excellent" (see Figure 1, blue and green bars).

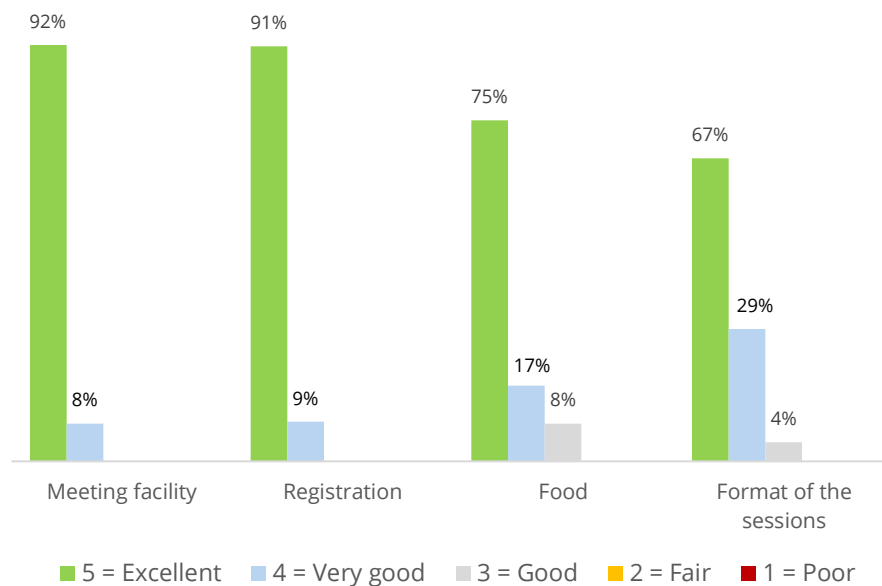


Figure 1: Quality of Logistics

There were 10 participants who made a comment (responses were optional). Several participants commented positively on the meeting space, food, and facilitative model. One participant noted, *“Loved the collaborative format of all the sessions, really want to continue this every year as it was super helpful.”* A second participant alluded to the high quality of the conference along with the need to have these types of across-ERC working meetings by saying, *“This was a WELL-ORGANIZED and EXTREMELY VALUABLE meeting for ERC leaders that I wish I had the opportunity to attend before taking on this role.”*

Usefulness of sessions rating. All of the sessions were rated by the majority of participants as “Useful” (blue bars) or “Very useful” (green bars). In fact, no participants rated any of the sessions as only “A little useful” or “Not at all useful” (see Figure 2).

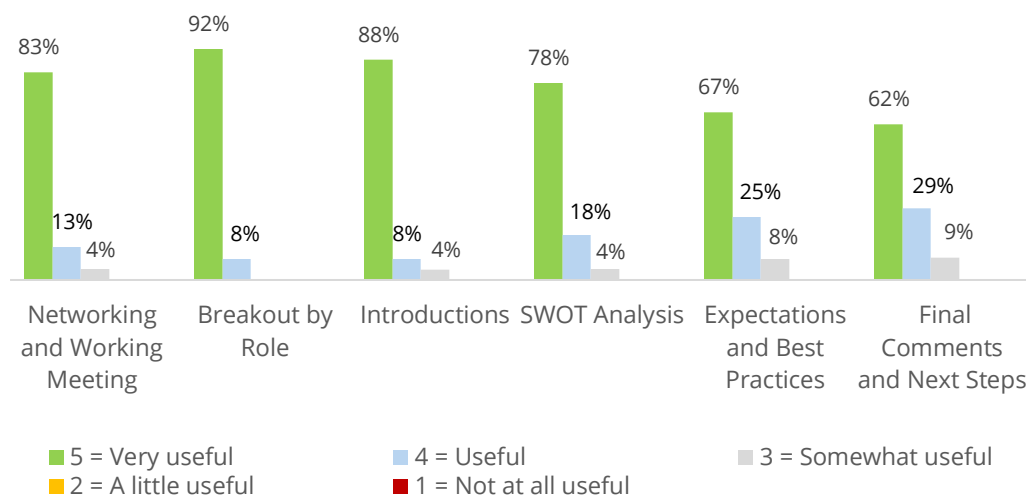


Figure 2: Usefulness of the Sessions

Sense of community and networking ratings. As can be seen in Figures 3.1 and 3.2, a large percentage of participants responded with “very much so” (blue bars) or “a great deal” (green bars) to questions about the conference promoting community building (92% to 96% range) and to the questions related to the conference promoting networking/information sharing (all 100%). No participants rated any of these survey questions “A little” or “Not at all.”

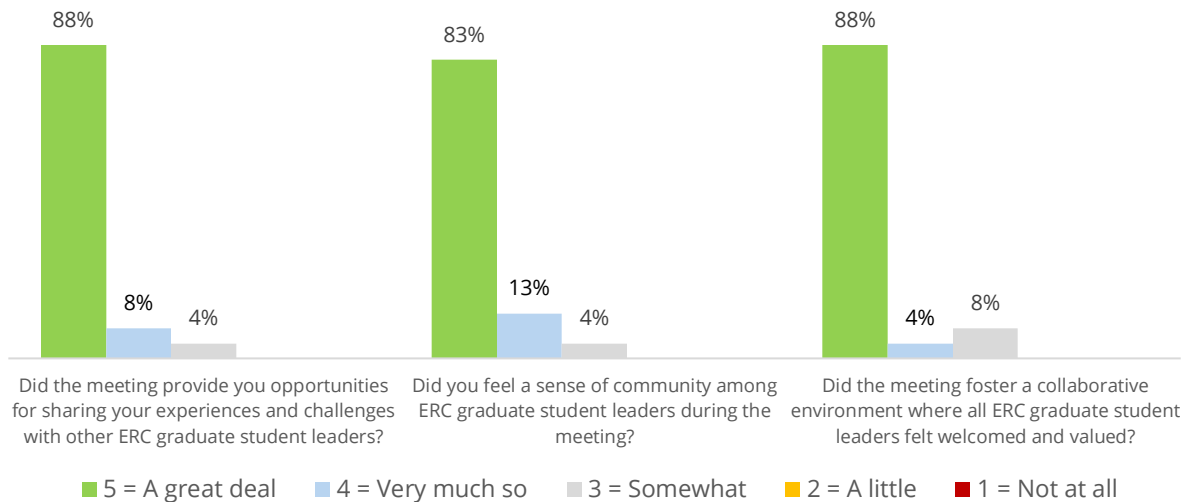


Figure 3.1: Conference Promoting Community-Building

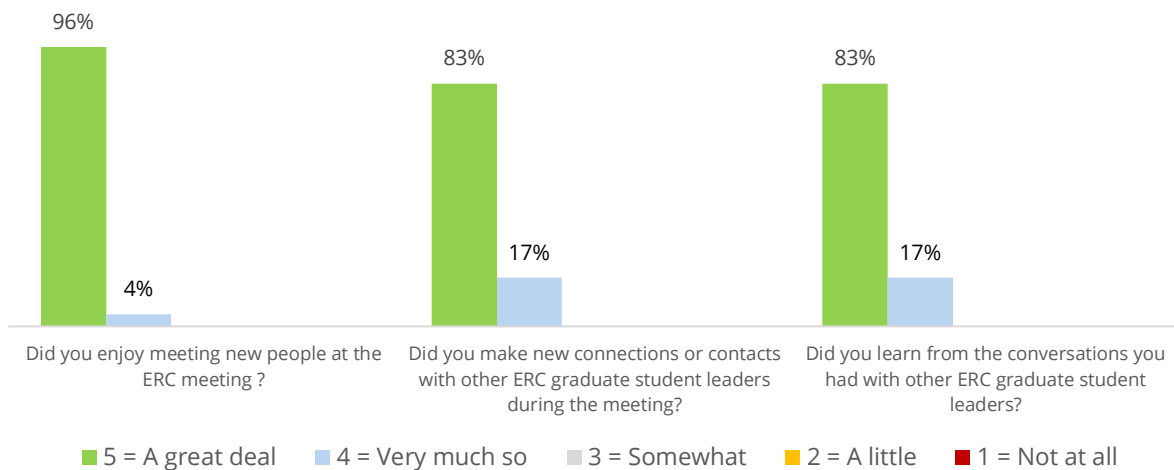


Figure 3.2: Conference Promoting Networking and Information Sharing

There were 15 comments (optional) that expanded on participants’ responses; all comments were positive and several were quite lengthy. One participant said, “*I felt extremely validated and supported by this group of peers! I learned a lot from them and also had a ton of fun! We were able to relate to each other on a profound level about our similar experiences in our respective*

ERCs. Another participant said, “Everyone was respectful toward one other, and we were able to be honest without the supervision of our directors or PIs, which enabled us to get a lot of problem-solving done. I also discussed research collaboration opportunities with some peers and other opportunities for cross-ERC events!”

Several comments reveal how it was particularly helpful for those new to their role in the SLC. As one participant new to the SLC said, “I learned so much! About the budget, how different SLCs are structured, the types of grants/fellowships, events, and opportunities they provide to their students, and it will hands-down be things that I will incorporate into our SLC.”

Planning collaborations with other leaders. Collaboration was another conference goal assessed by the survey. It was considered a measure of success if student leaders reported they were likely to collaborate in the future with another student who was at the meeting. Twenty-two of 24 participants (92%) responded that they were “likely” (blue bars) or “very likely” (green bars) to collaborate with another meeting participant in the future (see Figure 4).

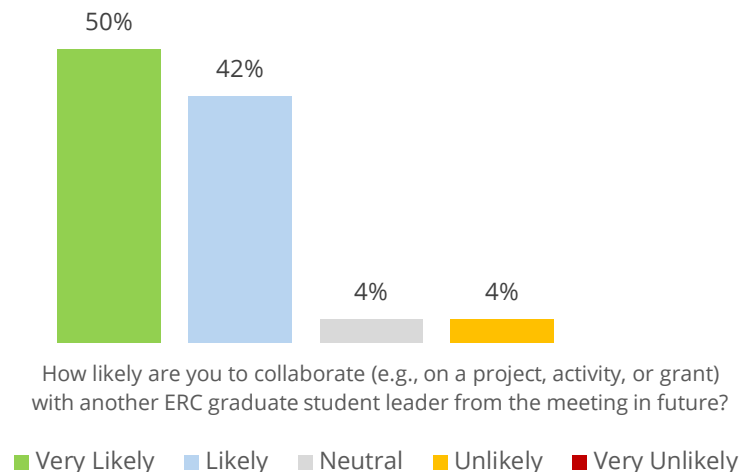


Figure 4: Likely to Collaborate

Participants were also asked, “Did you talk about collaborating on a specific project or activity with other ERC graduate student leaders?” More than half of participants said “yes” (57%); the remainder said “no,” and one participant did not respond. Those saying “yes” were then asked to write down the general topic or activity of interest. Some examples were:

1. Planning Cross-ERC Joint Professional Development Events – those strengthening communication and support (e.g., monthly Zoom meetings, meeting on Gatherly, or undergraduate exchange). Could also be a brainstorming session.
2. Planning Research Collaboration or Curriculum Program (e.g., execute a shared research project, collaborate on REU curriculum needed).

Planning best practice rating. Another way to get a measure of action-oriented potential, or participant likelihood to act following the meeting, is to get a measure of intent or planned

behavior [13]. That, in itself, has been shown by research to help make the actual behavioral outcome more likely. Thus, participants were asked, “Did you learn a best practice that you plan to implement?” Twenty-two participants (92%) responded positively (see Figure 5).

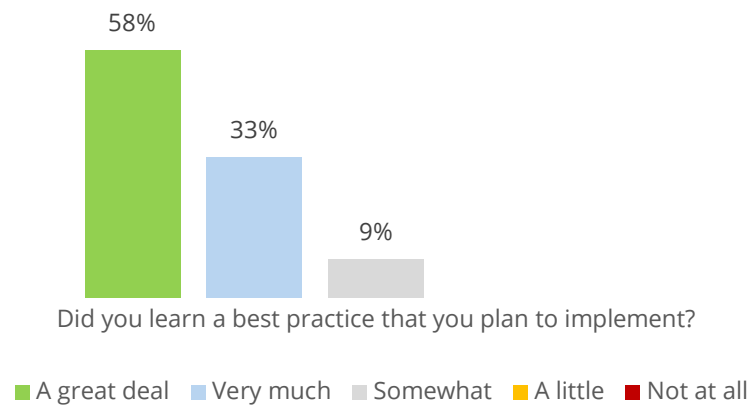


Figure 5: Plan to Implement a Best Practice

Thus, almost all participants intended to implement a best practice upon returning to their home ERC. Participants then elaborated on what they plan to implement to help strengthen the link between intentions and actions. Thirty-seven examples were reported, including such plans as introducing IDPs (Individual Development Plans) as a tool to support student growth and track progress, plans to improve onboarding processes for new ERC students, as well as writing a master document of lab equipment between all institutions in the center.

Recommend another meeting. Participants were asked “Would you recommend having such a working meeting again?” Overwhelmingly, participants said “yes” (N=23); only one student said “maybe” (see Figure 6).

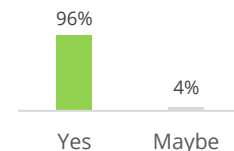


Figure 6: Recommend?

Even though comments were optional, there were 21 comments. Again, they were all positive. For example, one participant said, *“I 10000% recommend having another meeting like this annually. I learned so much and feel super prepared for my term as SLC president. I have a plan, I am clear on NSF expectations and rules, and I know I have a support system behind me to discuss future challenges/successes.”* There were also several comments talking about being energized, such as *“This felt crucial to my development as a student leader, and I now feel more inspired and enabled to do the important work of being an SLC officer.”*

When asked to respond as to the value of the cross-ERC meeting (22 responses), they overwhelmingly used words such as *“invaluable”* and *“essential”* and *“transformative.”* The topics highlighted by their extensive comments are echoed in all of the earlier data -- how they now have more clarity and direction, more networking and peer support, more knowledge and best practices, and better understanding of the importance of sustainability and continuity. In short, as one participant predicted, *“This meeting was EXTREMELY valuable to each of us. I think our NSF program managers will all see a vast improvement in the effectiveness and productivity of our SLCs, which is a direct result of this meeting.”*

Facilitator Perspectives

The two facilitators were asked separately to respond in writing to a series of questions about their perceptions of the meeting outcomes. Facilitators' reflections reinforced survey findings, emphasizing the extent to which participants engaged in peer mentoring and shared problem-solving. Facilitators observed that leaders from more established ERCs frequently advised those from newer centers, particularly on navigating NSF expectations, increasing student engagement, and sustaining participation. An example given by a facilitator was, "*Students from Gen 3 ERC's had advice to offer for Gen 4 ERC's and offered examples of changes implemented since 2024 and how they navigate directors, coordinators and the NSF requirements for student SWOT analysis.*"

Rather than emphasizing inspiration or motivation alone, facilitators, too, noted that participants appeared to feel validated and supported through recognizing shared challenges across ERCs. This validation contributed to increased clarity and confidence in fulfilling SLC responsibilities. The facilitators also talked about how student leaders valued the in-person nature of the meeting so they could honestly share challenges. As one facilitator wrote, "*...there is also a sense of security the students have when meeting in person, where they expressed their ability to speak freely, without worry, where online video calls can easily be recorded.*"

Follow-Up Actions and Sustainability

Follow-up communications indicated that several ERCs implemented changes inspired by the meeting, including adoption of Individual Development Plans, improved onboarding processes, expanded professional development offerings, and increased institutional support for student-led initiatives. Participants also reported ongoing use of shared communication platforms to maintain connections.

Despite these positive outcomes, sustaining momentum remains a challenge due to leadership turnover and limited structural incentives for cross-ERC collaboration. These findings underscore the importance of recurring opportunities for connection and mentoring among SLC leaders.

Conclusions and Recommendations

This study demonstrated that a facilitated, in-person leadership meeting can effectively address critical gaps in preparation, mentoring, and continuity among graduate student leaders in NSF ERCs. Evidence from survey data, facilitator perspectives, and short-term follow-up suggests that the meeting strengthened leadership capacity, fostered cross-ERC community, and supported the transfer of effective practices into participants' home centers.

Importantly, these findings extend beyond the ERC context. Although designed for SLC leaders, the core elements of this intervention (facilitated peer learning, structured cross-institutional dialogue, intentional community building, and action-oriented planning), reflect broader principles of effective graduate leadership development. Graduate students across disciplines

frequently assume formal and informal leadership roles with limited preparation or mentoring, suggesting that similarly structured, in-person leadership meetings may serve as a scalable model for strengthening leadership capacity and professional growth in a wide range of environments.

The findings highlight the value of facilitation-based approaches that leverage participants' expertise while creating space for trust-building and shared learning. Based on these outcomes, it is recommended that NSF consider institutionalizing periodic leadership meetings for ERC SLC leaders, particularly in non-biennial meeting years, and potentially supplemented by interim virtual meetings.

Future evaluations of such meetings should examine longer-term impacts on ERC student outcomes and explore scalable models for sustaining peer mentoring networks amid fiscal and structural constraints. Sustaining the enthusiasm generated by this meeting will hopefully be a priority given its positive impact on the ERC community.

Acknowledgement

We would like to acknowledge that the work was completed as part of the National Science Foundation #1647722 grant to the Engineering Research Center for Innovative and Strategic Transformation of Alkane Resources (CISTAR). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

References

- [1] L. Preston and C. Lewis, Agents of Change: NSF's Engineering Research Centers—A History. Potomac, MD, USA: Lynn Preston Associates LLC, 2020. [Online]. Available: <https://erc-history.erc-assoc.org/erc-history/front-matter/>
- [2] R. Paul and L. G. C. Falls, "Engineering leadership education: A review of best practices," in Proceedings of the ASEE Annual Conference and Exposition, Seattle, WA, USA, 2015.
- [3] B. J. Bergiel, E. B. Bergiel, and P. W. Balsmeier, "Nature of virtual teams: A summary of their advantages and disadvantages," Management Research News, vol. 31, no. 2, pp. 99–110, 2008, doi: 10.1108/01409170810846821.
- [4] R. Nadler, "Understanding 'Zoom fatigue': Theorizing spatial dynamics as third skins in computer-mediated communication," Computers and Composition, vol. 58, p. 102613, 2020, doi: 10.1016/j.compcom.2020.102613.
- [5] K. Rosback, "Blind trust: Techniques for working in the virtual world," Apr. 2020. [Online]. Available: <https://katherinerosback.com/blind-trust/>
- [6] C. Sanyal and C. Rigby, "E-mentoring as a HRD intervention: An exploratory action research study within an international professional mentoring scheme," Human Resource Development International, vol. 20, no. 1, pp. 18–36, 2017, doi:

10.1080/13678868.2016.1220156.

[7] E. R. Zajdela, K. Huynh, A. L. Feig, R. J. Wiener, and D. M. Abrams, "Face-to-face or face-to-screen: A quantitative comparison of conference modalities," *PNAS Nexus*, vol. 4, no. 1, page 522, 2025, doi: 10.1093/pnasnexus/pgae522.

[8] D. Driscoll, J. Larson, K. Everett, M. Drummond Oakes, T. Chatman, and E. Deemer "Building a sustainable community of leaders across the National Science Foundation Engineering Research Centers: An Intentionally Designed Conference" 2026 ASEE Annual Conference and Exposition, Charlotte, NC, USA (in press).

[9] I. Ravn and S. Elsborg, "Facilitating learning at conferences," *International Journal of Learning and Change*, vol. 5, no. 1, pp. 84–98, 2011, doi: 10.1504/IJLC.2011.041873.

[10] M. Wan, "Transitioning from presenter to facilitator," in *Incidental Trainer*. Boca Raton, FL, USA: CRC Press, 2014, pp. 153–162, doi: 10.1201/b16069-21.

[11] J. R. Miller, "Approaching conferences as a stress management event," *Khronikos: The University of Maine Graduate History Student Blog*, Jan. 22, 2014. [Online]. Available: <http://khronikos.com/2014/01/22/approaching-conferences-as-a-stress-management-event/>

[12] R. Gifford, "Environmental psychology matters," *Annual Review of Psychology*, vol. 65, no. 1, pp. 541–579, 2014, doi: 10.1146/annurev-psych-010213-115048.

[13] M. Fishbein and I. Ajzen, *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*. Reading, MA, USA: Addison-Wesley, 1975.