

IUSE/PFE:RED Collaboration in Transformation

Carlos Diaz Alvarenga, California Polytechnic State University, San Luis Obispo

Dr. Andrea L. Schuman, California Polytechnic State University, San Luis Obispo

Andrea Schuman is an assistant professor in the Department of Computer Engineering at Cal Poly. She holds a Ph.D. in Engineering Education and an M.S. in Electrical Engineering from Virginia Tech, and a B.S. degree in Electrical Engineering from the University of Oklahoma. Her research interests include experiential teaching and learning in ECE, sociotechnical engineering development, and global engineering.

Dr. Andrew Danowitz, California Polytechnic State University, San Luis Obispo

Andrew Danowitz received his PhD in Electrical Engineering from Stanford University in 2014, and is currently an Associate Professor of Computer Engineering at California Polytechnic State University in San Luis Obispo. His research interests involve student mental health and accessibility in engineering education.

Dr. Lynne A Slivovsky, California Polytechnic State University, San Luis Obispo

Dr. Lynne Slivovsky is the Inaugural Chair of Computer Engineering at California Polytechnic State University, San Luis Obispo, California, USA.

Dr. Jane L. Lehr, California Polytechnic State University, San Luis Obispo

Jane Lehr is a Professor in Ethnic Studies and Women's and Gender Studies and Director of the Office of Student Research at California Polytechnic State University, San Luis Obispo. She is affiliated faculty in Computer Science & Software Engineering and

Dr. John Y Oliver, California Polytechnic State University, San Luis Obispo

Dr. Oliver is a professor of Electrical Engineering and Computer Engineering at Cal Poly, San Luis Obispo. His field of expertise is in computer architecture and system performance analysis, dabbler in cybersecurity and passionate about broadening pathway

Prof. Nina J. Truch

Prof. Truch is a lecturer in the communication studies department at Cal Poly.

Dr. Bridget Benson, California Polytechnic State University, San Luis Obispo

Bridget Benson received a Bachelor's degree in Computer Engineering at California Polytechnic State University San Luis Obispo in 2005, a Master's degree in Electrical and Computer Engineering at the University of California Santa Barbara in 2007 and a Ph

Dr. Lizabeth L Thompson P.E., California Polytechnic State University, San Luis Obispo

Lizabeth is a professor Emeritus at Cal Poly, SLO in Industrial and Manufacturing Engineering. She has been taught for 32 years and held various administrative positions. She also participated in multiple NSF grants over the time she spent at Cal Poly and also participated in a valuable collaboration with Cal State LA.

IUSE/PFE:RED Collaboration in Transformation

Abstract

This paper provides insights into the progress made in our department's NSF RED project (IUSE/PFE:RED 2234256) as it enters the middle stages. Cal Poly's Computer Engineering department is in a period of significant transformation that includes both developing policies as a young department and preparing for institutional change from quarters to semesters. During this time, we aim to involve a variety of stakeholders in collaborative transformation to expand capacity, interrupt inhibiting structures, and dismantle and replace structures of oppression.

Over the past two years we have engaged in a collaborative vision process that has brought together students, faculty, and other stakeholders to enact our vision for departmental culture change. As a result of these activities, we have seen significant student involvement in proposing and implementing student-focused programming and mentoring in the department. We are working together to reduce barriers to belonging in the department.

Another highlighted area of impact is pedagogical development, as we have analyzed syllabi in our department and found barriers to faculty redesign. We used these findings to lead a workshop on syllabus design. Finally, the faculty were asked to participate in a number of micro-retreats on the topic of critical mentoring and given the opportunity to enroll in the Inclusive STEM Teaching Project (ISTP). Discussions on these topics were held during regularly scheduled department meetings to ensure high levels of attendance and engagement. The implications of our work this year include both opportunities for change within our department and documentation of work that may be a resource to other institutions.

Introduction

Cal Poly's NSF-funded IUSE/RED grant team aims to reimagine structures within, impacting, and impacted by the department to enhance critical consciousness and expand group capacity. During the past year, we continued to use our Critical Collaborative Educational Change model [1] and built upon the faculty-led change initiatives to improve faculty, staff, and students' experiences [2].

Since department members' perspectives on education, engineering, and beyond shape how they believe, think, and act, we frame departmental reform as culture change [3], [4]. In the model for Critical Collaborative Educational Change, critical consciousness, values and beliefs, actions, and well-being shape each other [1]. Highlighted initiatives include micro-retreat sessions aimed at capacity-building for an inclusive culture, research examining the variation in syllabus design within the department, student involvement in department tutoring and mentoring initiatives, and implementation of a survey on students' challenges in the department.

Student Mentoring and Tutoring Services

Tutoring and mentoring within our department are critical student support services and serve as an important area of reflection in evaluating the student experience. With significant input from our students, the department implemented several changes during the past Fall quarter

to better address student needs. These revisions were designed to expand access to support services and promote positive experiences for students in our program.

The mentoring program, offered to our first-year students through the introductory Computer Engineering course, was redesigned to encourage long-lasting relationships between mentors and mentees. Many of our senior students noted that longevity is an important component of the mentoring experience. An opt-in participation model was introduced to ensure that students who choose to participate are willing to commit to the necessary time outside of class for a meaningful experience. To create more compatible mentor-mentee matches, we additionally implemented a new pairing process that incorporates student identities, interests, and preferences.

Preliminary feedback from students shows that under the new opt-in model, mentors are paired with smaller mentee groups. Students report forming closer bonds with mentors because of the smaller . Another point of feedback is that, with the new identity-based pairings and a focus on different academic and hobby interests, the pairings feel more genuine. The new recruitment form for both mentors and mentees allowed them to share information about their identities, interests in engineering topics, hobbies, preferred mentoring style, availability, and more. A survey is planned for future data collection to explore students' perspectives on these changes more in-depth.

At the same time, the department tutoring center has begun collaborating with Cal Poly's Office of Learning and Writing Tutoring and Learning Center to expand the availability of tutoring resources and strengthen tutor preparation within the department. Currently, Computer Engineering tutoring services operate primarily in the evenings and are staffed by senior undergraduate students. This new partnership seeks to broaden access by introducing daytime tutoring at the Tutoring and Learning Center, while also aligning departmental practices with campus-wide standards. In addition, the department is in the process of implementing classroom visits to increase student awareness of tutoring services and revising tutor training to incorporate online workshops provided through the partnership. Together, these efforts aim to expand resource availability and create a more supportive and inclusive learning environment for a diverse student population.

Faculty Microretreats

To enhance faculty awareness and competences around the topic of department culture change, we conducted nine micro-retreat sessions during the 2024-2025 academic year. The retreat topics are summarized in Table 1. Topics ranged from best-practices in student mentoring to a series of modules inspired by the Inclusive STEM Teaching Project (ISTP) [5] which was offered in partnership with Cal Poly's Center for Teaching and Learning Technology. For the ISTP sessions, faculty were offered a paid stipend to complete the formal ISTP course. All faculty, regardless of formal ISTP course enrollment were invited to discuss topics discussed in the ISTP course at the corresponding microretreats.

Table 1. A list of microretreat sessions and topics held during the 2024–2025 academic year.

<i>Session</i>	<i>Topic</i>
Mentoring 1	Asset vs. deficit thinking
Mentoring 2	Community cultural wealth

Mentoring 3	Equity mindedness and faculty evaluation
Mentoring 4	The iceberg model
ISTP 1	Introduction to ISTP
ISTP 2	Inclusion in learning and teaching in higher education and instructor identity and experience in STEM classrooms”
ISTP 3	Student identity
ISTP 4	Creating an inclusive STEM course
ISTP 5	Climate in the STEM classroom

To ensure broad faculty participation, these meetings were held during regularly scheduled department meetings. Special sessions were also held during catered end-of-quarter department luncheons. Faculty feedback was collected on each microretreat session, and will be used to inform the design of microretreats going forward.

Sociotechnical Content Integration

To further our goal of breaking the traditional socio-technical “binary,” socio-technical course content (STCC) was developed and is being piloted in required undergraduate CPE courses. STCC is being developed with the following goals.

1. Connecting Technical Work to Social Contexts

STCC materials show how engineering decisions shape society with both intentional and nonintentional impacts. We explore how social values and power structures influence these design choices and how the harms of technology are disproportionately applied to the most vulnerable populations.

2. Developing Ethics and Responsibility

These materials help students recognize ethical dimensions of engineering practice, such as: public safety; equity and justice; and environmental impact. We discuss the accountability of designers and professional manufacturers of technology.

3. Improving Design Quality and Real-World Effectiveness

By considering social responsibility, students are challenged to holistically consider stakeholder needs as part of the design process.

4. Build Student Critical Thinking and Reflection Skills

STCC materials often use case studies, reflective prompts, and discussion activities to help students question their assumptions and better evaluate disparate stakeholder perspectives.

5. Provide Exemplar STCC material that is integrated into Engineering coursework

Social and ethical considerations are embedded directly into technical content so that students see these issues as essential parts of the engineering practice.

As part of this effort, we draw upon several frameworks, such as the Technoskeptical Framework and Iceberg from the Civics of Technology [6], Design Justice Network [7], Sclove's Democracy and Technology [8], and Benjamin's Race After Technology: The New Jim Code [9].

We have developed prototype STCC materials for an embedded systems course and are currently creating materials for courses in discrete signals and systems and assembly language programming. Planned evaluation methods include student surveys, interviews, and classroom observations, as well as faculty interviews. Preliminary student feedback on STCC has been positive, though some students have expressed a desire for greater detail in the STCC material. The largest concern is providing instructors enough support where they feel prepared to deliver STCC materials. Upcoming dissemination of results will include an exploration of engineering faculty's feelings about teaching sociotechnical lessons during an engineering course.

Syllabus Analysis

As part of the prior year of work, we analyzed syllabi from two junior-year CPE courses—Computer Architecture and Microcontrollers & Embedded Applications [10]. Artifact analysis, the main goal of this research, included annotating and analyzing syllabi from these classes after receiving approval from the Institutional Review Board to conduct Human Subjects Research. Using qualitative methods such as memoing, we facilitated the aforementioned artifact analysis and visualized results using concept-mapping—a way of linking information in an individualized manner in order to gain a better understanding of the bigger picture.

The results indicate that even though our Computer Engineering Department has started including changes to its curriculum to make it more equitable, some professors' syllabi could benefit from additional work in the context of justice-orientation. Even within a shared class structure, variations within language and policy can lead to distinct learning experiences for students. Since these are junior-level CPE courses, transfer students might not be aware of resources, policies, or other information relevant to the course. These differences could especially impact female students of color, who might already struggle with belonging in a predominantly white and male major. The lack of cultural recognition in some of these syllabi could play a large part in this. None of these syllabi included Land Acknowledgments, which was previously mentioned as a suggestion to include. By incorporating cultural awareness, professors could re-affirm their commitment to all students.

Due to the sample constraints of only two courses, not enough information is available for in-depth analysis between multiple course offerings for the same requirement. For example, Computer Architecture and Computer Hardware Architecture and Design fill in the same requirement, as well as Microcontrollers & Embedded Applications and Microcontroller-Based Systems Design. This research sets the groundwork for developing tools that professors in Computer Engineering can use to transform their syllabi into documents that reaffirm students' belonging in engineering, rather than excluding them. Hopefully, professors in the future will include key aspects such as ethics and accessibility-based assignments, and the incorporation of Land Acknowledgments into their syllabus.

Department Culture

Finally, we continued our research into student's perceptions of department culture and how it affects academic anxiety and intent to persist in computer engineering. Over the last year, we have completed additional data collections using our survey instrument and explored specific student-reported barriers to inclusion, with results highlighting significant workload and peer competition [11], [12]. As of submission, we are also conducting a regression analysis to determine whether and to what extent factors like department culture, student experiences with faculty and peer interactions, and CPE identity contribute to academic anxiety and intent to persist. The results will be disseminated and we aim to use the analyses to target interventions in future years to improve student success rates.

Acknowledgement

This material is based upon work supported by the National Science Foundation under Grant No. 2234256. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

References

- [1] L. A. Slivovsky, L. L. Thompson, J. L. Lehr, B. Benson, A. Danowitz, and J. Y. Oliver, "Board 325: IUOE/PFE: RED Innovation: Breaking the Binary," in *2024 ASEE Annual Conference & Exposition*, 2024.
- [2] L. A. Slivovsky *et al.*, "BOARD # 433: RED: Faculty Co-Create Community, Mentoring, Transformation," presented at the 2025 ASEE Annual Conference & Exposition, Jun. 2025. Accessed: Jan. 18, 2026. [Online]. Available: <https://peer.asee.org/board-433-red-faculty-co-create-community-mentoring-transformation>
- [3] T. Edmonds and M. Chua, "Aspects that influence curricular change capacity: Characterizing the transferability, openness, and literacy of individual changemakers," in *2017 IEEE Frontiers in Education Conference (FIE)*, Oct. 2017, pp. 1–4. doi: 10.1109/FIE.2017.8190638.
- [4] T. Edmonds and J. Stolk, "Developing a framework for collaborative educational change: A study of people, processes, and cultures," in *2018 IEEE Frontiers in Education Conference (FIE)*, Oct. 2018, pp. 1–5. doi: 10.1109/FIE.2018.8659099.
- [5] S. Calkins *et al.*, "Scaling inclusive teaching: a national STEM teaching initiative centering identity, power, and privilege," *Change Mag. High. Learn.*, vol. 56, no. 5, pp. 31–40, 2024, doi: 10.1080/00091383.2024.2385271.
- [6] "Civics of Technology," Civics of Technology. Accessed: Jan. 18, 2026. [Online]. Available: <https://www.civicsoftechnology.org>
- [7] "Design Justice Network," Design Justice Network. Accessed: Jan. 18, 2026. [Online]. Available: <https://designjustice.org>
- [8] R. E. Sclove, "The social shaping of technology," in *Democracy and Technology*, New York, NY: The Guilford Press, 1995.
- [9] R. Benjamin, *Race After Technology: Abolitionist Tools for the New Jim Code*. Cambridge, UK ; Medford, MA: Polity, 2020.
- [10] S. M. Martyrossian, J. L. Lehr, G. Medina-Kim, L. L. Thompson, and L. A. Slivovsky, "Thematic Analysis of Junior-Level Computer Engineering Syllabi," presented at the 2025 ASEE Annual Conference & Exposition, Jun. 2025. [Online]. Available: <https://peer.asee.org/thematic-analysis-of-junior-level-computer-engineering-syllabi>
- [11] Andrew Danowitz and Lynne Slivovsky, "Barriers to Belonging: An Analysis of Student Perceptions of Culture and Inclusivity in a Computer Engineering Program," in *2025 ASEE Annual Conference & Exposition*, Montreal, Jun. 2025.

- [12] A. Danowitz and L. Slivovsky, "WIP: Exploring student reported barriers to success in a computer engineering department," in *2025 IEEE frontiers in education conference (FIE)*, 2025, pp. 1–5. doi: 10.1109/FIE63693.2025.11328329.