

## **Board 325: IUSE/PFE:RED Innovation: Breaking the Binary**

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## **Abstract**

This paper introduces our NSF RED project Breaking the Binary (IUSE/PFE:RED 2234256). Our project is designed to engage computer engineering faculty members, students, and other stakeholders in a substantial process of collaborative transformation that involves rejecting binaries or dualisms commonly used to create hierarchies in engineering thought and practice (rational-emotional, male-female, social-technical, mental-manual, hard-soft, concrete-abstract, etc.) and embracing a complex coexistence; developing new skills in co-creation of holistic learning experiences and inclusive cultures; and evolving personal and professional identities that are constantly challenged and often in flux. While individual and group differences in beliefs, values, and identities are always present during change processes, these differences are often implicit and unexamined. Our project will make these differences a visible component of critical reflection and generative dialogue, in service to both educational research and practice, and aligned with capacity building for critical awareness and action.

As our project is only in its first of five years and focuses on individual capacity building and department culture transformation, we currently have limited qualitative and quantitative results to report. Therefore, this paper focuses primarily on our project's motivation, proposed scope of work, and early research steps. This paper also discusses our model for change, Critical Collaborative Educational Change, which is an iterative reinforcing loop showing reinforcing relationships among critical consciousness, values and beliefs, actions, and collective well-being.

## **Introduction**

The Computer Engineering program (CPE) is one of 13 degree programs offered in the College of Engineering at California Polytechnic State University. It is the 2024 number one computer engineering program at a non-doctorate granting institution according to U.S. News & World Report [1], and is known for its *Learn by Doing* approach to education. Our graduates are highly sought after, and many graduates pursue full-time employment with large tech companies. The program is in demand for incoming students. On average, CPE receives 1500 first-time freshman (FTF) applications, and enrolls 100 FTF students. CPE only graduates 70 students per year, however, and the program's six-year graduation rate is 73%. Disqualification rates for underrepresented minority students are 230% greater than for white students. Likewise, female students are 60% more likely than male students to be dismissed from CPE. In the last two years 123 students have switched out of CPE and 68 have switched in. Most who leave change major to computer science or software engineering. Women are 35% more likely to change major out of CPE than men, and students of color are 45% more likely to change major out than white students.

For such a highly ranked and in-demand program, why do these patterns exist? CPE was created 34 years ago as a program jointly offered by the Computer Science (CS)

department and Electrical Engineering (EE) department. The program was designed as a 50-50 split of coursework and faculty representation from the two sponsoring departments. Despite the maturation of the CPE field, this 50-50 structural balance has persisted in our curriculum. This split necessitates a kind of code switching for CPE students between CS and EE coursework, creating challenges that lead many students to turn away from CPE. Despite a recent transition from program to department, inertia from the CS-EE binary persists in our curriculum and in the patchwork of policies and procedures inherited by the former sponsoring departments. This legacy hampers CPE students as they strive to develop a sense of engineering identity, belongingness, and self-efficacy and makes it difficult for CPE faculty and staff as they work to build a sense of identity, community, and culture in the CPE department.

This current condition provides an opportunity for change: Change that leads to new knowledge on transforming a department culture to be inclusive, innovative, equitable, and supportive of faculty and students; change that is woven into new department policies, procedures, and practices; change that creates a new culture and learning modes that break the sociotechnical binary across the CPE core curriculum; change that affects both FTF and our growing transfer student population.

This change is the focus of our NSF RED Grant, Breaking the Binary. Our aim is not only to move beyond the historic CS-EE binary that has held our students back, it is to entirely reexamine our culture as an engineering department to challenge binaries or dualisms commonly used to create hierarchies in engineering thought and practice (rational-emotional, male-female, social-technical, mental-manual, hard-soft, concrete-abstract).

As a new department, it is our hope that the CPE change initiative may offer a model for creative departmental design within emerging and growing fields. With its attentiveness to deep cultural change, focus on faculty development, and a rejection of binaries within engineering, our research aims to break new ground in inclusion.

As this is the first year of our grant, there are few results to discuss. Therefore, this paper is primarily dedicated to sharing the theoretical underpinnings of our work and introducing our collaborative change model, Critical Collaborative Educational Change, that will form the basis for our work over the five-year grant period.

## **Background**

Our project emphasizes culture change with a focus on faculty in our proposed work. We draw from Schein's definition of culture, which depicts culture as operating on three levels: (a) artifacts—visible phenomena including physical space, published goals, activities, and observed behaviors; (b) espoused beliefs and values—ideals, aspirations, including articulations of why a group does what it does; and (c) basic underlying assumptions—unconscious, taken-for-granted beliefs and values that shape behavior, perception, thought, and feeling [2]. We find it useful to frame departmental reform as culture change, since the departmental context is shaped by faculty members' basic assumptions about

engineering, education, and the world which give rise to beliefs, values, and identities that ultimately manifest as observable aspects of curricula and pedagogy [3], [4]. In addition, our work is greatly informed by the Highlander Theory of Change [5], [6], which is based on gathering individuals for community dialogues. The dialogues are grounded in an inquiry process that emphasizes practice and reflection to develop theory. It assumes that the individuals impacted by an oppressive system are the best people to develop solutions and advocate for system changes. Over the course of this project, we intend to change department culture in pursuit of three goals: 1) enhancing critical consciousness and expanding group capacity among faculty to enact change; 2) interrupting existing structures that inhibit action; and 3) dismantling and reimagining structures of oppression within CPE.

### Change Model

As part of this work, we have developed an institutional change model, Critical Collaborative Educational Change, to guide our research and culture change during this project. The model, highlighted in Figure 1, is built around an iterative loop of reinforcing relationships among critical consciousness, values and beliefs, actions, and collective well-being.

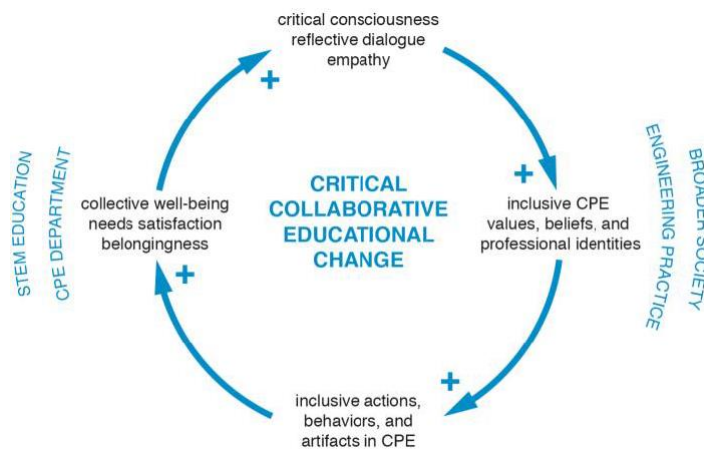


Figure 1. Change model to be used to create a more inclusive CPE culture.

The change model is based on two tenets. First, change and healing in any system begin with the individuals in the system changing and healing through reexamining assumptions and mental models, including beliefs and values. Second, since individuals make up a system and culture, as individuals change, heal, and re-engage, the system will also change and heal. Evidence suggests that a change process that begins with individuals’ mental models—especially leaders’ [7]—and that accounts for emotions and desires [8], is effective to successfully bring forth change in an organization.

### Initial Steps

As fundamental culture change is a difficult and involved process, the first year of the grant has largely focused on planning and logistics to build the foundation for a successful

transformation process. To encourage critical consciousness and reflective dialog among the grant planning team, we first developed a set of meeting and discussion norms, Table 1, to govern how we interact with each other. We have also worked with a campus program (\*\*name redacted) designed to provide research opportunities and mentoring for students from marginalized groups to recruit three student researchers to the project.

Table 1. Group norms and behaviors.

| <b>Qualities and Aspirations</b><br>We intend to.....                              | <b>Practices and Traditions</b><br>We intend to .....  |
|--|--|
| Practice unconditional positive regard   | Check-in at the beginning of each meeting  |
| Share leadership and prioritize collective work so we don't feel alone in the work | Take breaks to mindfully center ourselves in our bodies  |
| Learn and value each other's expectations  | Be clear about how decisions are made  |
| Create spaciousness  | Discuss the undiscussable  |
| Try to be suspicious of our own opinions   | Be present and aware of technology and other distractions  |
| Value our individual and collective expertise                                      | Build capacity to cover Logistic details, attend to developmental activities, and spend time on strategic issues |
| Stay even when it is hard (but not if it is oppressive)                            | Avoid monologues by being curious  |
| Value Transparency and accountability  | Create spaces for multiple truths  |
| Increase our ability to see our own culture and biases                             | Be present except when you can't   |
| Look for learning  | Critique structures not people   |
|  | Always welcome people back   |

As part of our early research activities, we have engaged faculty both in CPE and in the College of Engineering in general in a survey designed to collect faculty baseline attitudes towards students, engineering, and institutional culture. The results of this survey will provide baseline data on CPE faculty's current awareness of issues facing our students and their receptiveness to fundamental institutional change to a more equitable and inclusive department. With data from engineering faculty across engineering, we plan to identify any departments that have already built an inclusive culture so that we can learn from and build on the foundations of their success. We have also engaged our computer engineering faculty in a micro-retreat to introduce them to the RED project and the project's goals.

Our goals for the remainder of the academic year include conducting interviews of department faculty, staff, and college administrators to further explore trends and results from our survey. We will also form a student advisory group to provide input to the grant team and the department as we work to remake the culture of computer engineering.

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