Board 82: Sustaining Change: Embedding Research Outcomes into School Practices, Policies and Norms

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Sustaining Change: Embedding Research Outcomes into School Practices, Policies and Norms

With an NSF Revolutionizing Engineering and Computer Science Departments (RED) grant, the School of Chemical, Biological and Environmental Engineering seeks to create (1) a culture where everyone in the CBEE community feels valued and that they belong, and (2) to create a learning environment that prompts students and faculty to meaningfully connect curricular and co-curricular activities and experiences to each other and to professional practice. We aim to have students connect what they learn to the context of their lives, identities, and emerging careers. We want CBEE graduates to be dramatically better prepared to apply their knowledge to whatever new and unpredictable challenges face our society in the years to come. This work is resourced by a grant from the National Science Foundation's REvolutionizing engineering and computer science Departments (RED) program, but is really owned by the CBEE community.

The third and fourth year of the grant is characterized by a focus on institutional transformation – embedding practices, processes, course structures, and policies that will continue beyond the duration of the grant with the goals of building an inclusive culture for students, faculty and staff, and creating a professionally-based learning environment that promotes development of student's skills to navigate the world of engineering. This paper discusses these efforts in the context of the curricula and teaching practices and the School community.

Curricula and Teaching Practices

One critique of engineering curriculum is that when students graduate, they are unprepared to connect the knowledge they learned in the classroom to the messy, open-ended work they face in engineering practice [1]. The focus of curriculum reform been towards shifting activity to meaningful, consequential learning in eleven core studio courses. Meaningful, consequential learning positions students in the role of engineers where they need to identify core foundational principles as conceptual tools that enable their work [2]. We draw upon Engle and Conant's [3] productive disciplinary engagement to describe engineering students use of concepts, practices, and discourses of engineering to "get somewhere" (develop a process or product, gain better understanding) over time. We describe this approach in more detail in Koretsky et al. [4].

In the past year of the grant, considerable effort was invested in spreading the revolution out to include more of the faculty in CBEE. Activities have included developing and evaluating re-situated activities in 11 studio course courses, testing a variety of teaming activities with senior students and soliciting their feedback, and creating a Teaching Innovation Fellows program for School faculty to work on common issues by participating in one or more of several new professional learning communities or by engaging in action research. We have expanded the use and professional development of near-peer Learning Assistants to facilitate course continuous improvement. Video studies of student teams engaging in re-situated Studio 2.0 activities have informed both activity development and instructional practice. We are piloting an alternative leads model, a strategy to institute innovation and issues of practice as a core instructional activity rather than work supported by external funds. In select studio courses, two faculty share a course assignment with one orienting towards that year's delivery and the other taking

responsibility for curricular innovation and instructional practice. These activities are described in more detail in the following sections.

Teaching Innovation Fellows:

Modeled after the Action Research Fellows Program of the ESTEME@OSU community, the Teaching Innovation Fellows Program is designed to support CBEE instructors and staff to take the next step in educational innovation through participation in a Professional Learning Community (PLC) and action research while addressing project goals. The PLC option is designed to encourage teaching or co- curricular development and reflection without the need to formally collect and analyze data, though we encourage assessment of current and/or reformed teaching/co-curricular practice through evaluation of informal measures (e.g., observations of groups, feedback from TAs and LAs) and artifacts or work products (e.g., completed assignments, exams). Each project is resourced with $1,000. The Action Research (AR) option is designed to encourage teaching or co-curricular development and reflection using an action research approach, through which people ask and empirically investigate questions about practice. AR Fellows collect evidence in their own classroom/co-curricular environment to inform practice. Each project is resourced with $3,000.

The call for applications to the Teaching Innovation Fellows Program was issued in Summer 2018 and the first cohort was selected in early Fall. There was widespread response and the faculty teams that were selected are shown in Table 1. To sustain collaboration and activity, the Fellows meet with the community of fellows once a quarter during the year of the fellowship to reflect on your teaching/co-curricular innovation and discuss and refine research plans, including approaches to analysis, results, and dissemination. They also are required to present their work at an annual Revolution in CBEE event. In addition, the Action Research Fellows are required to present a paper or poster at a conference or submit an article to a peer-reviewed journal.

Table 1. First cohort of Teaching Innovation Fellows Program

#	Title	Faculty
1	Inclusive Teaming	Nick AuYeung, Michelle Bothwell, Trevor Carlisle, Susannah Davis, Natasha Mallette
2	Vertical Integration of Writing in the CBEE Curriculum	Nick AuYeung, Trevor Carlisle, Elain Fu, Phil Harding, Christine Kelly, Natasha Mallette, Devlin Montfort, Jeff Nason, Skip Rochefort
3	Vertical Integration of Process Simulation in the CBEE Curriculum	Nick AuYeung, Natasha Mallette
4	Vertical Integration of Cross-Disciplinary Coursework and Advanced Computation in the CBEE Curriculum	Kate Schilke, Christine Kelly
5	Balancing Student Assessment and Inclusivity in a Critical Introductory Course	Phil Harding
6	Improving the Instructional Practices of Senior-Level ENVE Courses: ENVE 456	Stacey Harper, Devlin Montfort
7	Professional Competency Development in Bioengineering Graduate Students through Embedded Co-Curricular Activities across Core Curriculum	Morgan Giers, Adam Higgins, Elain Fu, Kevin Brown, Jim Sweeney, Mike Pavol

Alternating Leads Studio Instruction Model

We are piloting the Alternative Leads Studio Model (ALT Studio 2.0) to increase the effectiveness of the use of teaching resources in the School. This model was developed through discussions on the School Curriculum Committee and refined after discussions with School administration. It was then discussed with the entire faculty at the faculty meeting where a pilot program was approved for 2018-19.

Alt Studio 2.0 was developed to imbed time and resources for innovative curricular activities, a critical aspect of course delivery to more student-centered and socially just learning. Continuous revitalization of content also addresses persistent problems of student practices associated with repeating HW and studio activities. Since faculty are provided little time to innovate and are not appropriately evaluated or rewarded for it, we developed a structure that provides faculty time and support for ongoing, progressive development. We also wanted to free up faculty time for more interactions with students by being more efficient with logistical, technology, and delivery processes.

We hypothesize that the foundational structural change we propose will aid in an intended shift from a meritocratic, individualistic classroom culture to a more collaborative and inclusive environment and a shift from faculty-centered to student-centered classroom practices.

The major components of the Alternate Leads Studio Model

- Assign pairs of faculty to each major studio course.
- Each faculty member takes the lead in alternative years with the other working on activity development, student support, and being available when the lead travels. The alternate will also be available to contribute to longitudinal curricular coordination such as computation throughout the curriculum and inclusive teaming.
- While this structure would apply to each course, individual pairs have autonomy to work out detail as appropriate for their course, teaching practices, experience, and instructional goals.
- There is a preliminary four-year match period with potential renewal so that each pair can lead twice during each rotation period. Pairing is ultimately a personnel decision, but the chairs of the CBEE Curriculum and ABET will provide consultation.
- Part of the annual performance reviews will contain a meeting between the School Head and the faculty pair where the activity and accomplishments of each member will assessed and evaluated.
- New faculty will be paired with more experienced instructors. There will be documented development plans for new faculty that can become part of their teaching portfolio for P&T.
- There will be 1-2 optional meetings per term for studio faculty to share innovative practices and work through persistent problems.

Computations "Bridge" Course

Issues of student retention and course instructional stability with the current first year computations course led to the development of this curricular innovation. A core problem was the unequal preparation of students for the first year course in engineering computations. In short, some students would fly through an activity while others struggled slowly through it. This variation has led to several issues in activity design and course management.

The School Curriculum Committee developed a new model to address first-year computation. It would place an intermediate course as an engineering elective between the orientation course and the required computations course. By transferring one of the engineering science electives from later in the curricula, students who needed this course could take it without an academic penalty. A critical element was the identified need for one or more faculty champions to provide coherence between the elective and required courses and also for vertical integration of computations throughout the curriculum. A core member of the RED project team has agreed to take on this role.

The bridge course was approved by representatives of all three programs and refined with discussion of the Associate School Head. This proposal was discussed at the faculty meeting on March 9, 2018 with general support from the faculty to move forward with this proposal. It was suggested a committee of Curriculum Committee members and CBEE faculty with interests in computation and computational thinking be convened to flesh out these ideas. An *ad hoc*

committee developed recommendations on the proposed two quarter sequence in Computations, including a process to develop learning outcomes and a syllabus for each class. Central to the discussion were both:

1. Strategies of how computational (algorithmic) thinking skills will be developed.
2. Strategies for community building around a cohort model.

The recruitment of students in ways that did not shame them with a remedial course is viewed as critical. Recruitment strategies focused on interacting with students in the CBEE Orientation course with the following approaches being discussed:

1. Just frame it and let them chose
2. Develop a computational thinking activity for them to assess their level and make a more informed choice
3. Develop a survey that the advisors assess and select in
4. Show videos of different high school environments to show different social and cultural opportunities and normalize acceptance

The new course went through the university approval process, but was approved too late for 2018-19, so a pilot is tentatively scheduled for 2019-20. After this program was proposed, the College has instigated a plan to restructure the entire first year. We are now working on ways this innovative bridge course can align with the College's goals for restructuring.

Teaching 10

We have initiated a process of starting faculty meetings with 10 minutes of discussion on teaching skills, perspectives, and approaches. The strategy was to start with more practical topics (e.g., working with a teaching team (TAs, LAs, co-instructors) and evolve in sophistication (Asset vs. deficit perspective). We initially envisioned it as a high quality five minute presentation on a specific topic, followed by five minutes of discussion, but after a couple of instances modified it to asking a provocative question or making a claim (e.g., ""In your class, there is at least one assignment that yields less learning because it is graded") and allotting almost the entire time for discussion. At the insistence of a research-focused faculty member, the Teaching 10 also was alternated with a Research 10. A list of topics we are progressing through is:

- Working with a teaching team (TAs/LAs/co-instructors)
- Survey (concept warehouse) about breakdown on grade weights in classes with studios, discuss pros/cons.
- How to use a surface to prepare videos to aid instruction
- How long should an exam be?
- Concept warehouse
- Studio assessment (general)
- How to best use the LINC classrooms
- Inclusive teaming, how status impacts learning
- Concept of vertical integration (computing, writing, statistics, etc.)

- Assessing solution vs. process, and what kind of thinking this elicits.
- Sense making vs. procedural studios
- 'Decenter' as perfect expert
- Deep vs. surface learning
- Epistemology
- Apprenticeship or observation.
- Asset vs. deficit perspective.

Student team activity in Studio 2.0

We have regularly collected and analyzed video data of teams engaging with a realistic Studio 2.0 tasks. These data include an initial study in a controlled laboratory environment [5] and video collected every term "in the wild" among consenting students in their studio courses. While the Studio 2.0 activity was developed to provide an authentic context, the clinical setting in the first study enabled a low stress and supportive environment to form initial understanding of student reactions. We characterize the teams' engagement in terms of Dorothy Holland's figured worlds [6]. In "school world," students learn concepts and technical skills as part of school practices like studying for exams and answering decontextualized homework problems. In "engineering world" their work resembles more closely the activity of engineering practice where they use their knowledge and skills to make meaningful progress on a problem.

The video studies have provided us with a richer understanding of the multitude of ways teams could take up the challenge of a Studio 2.0 task and have provided a tool for improvement of activity design and for faculty, GTA, and LA professional development. We see school world and engineering world characterized by very different modes of participation and engagement. In our data, school world activity tends to be controlled by a dominant student and the warrants for reasoning point to what is appropriate for a course or topic. Engineering world activity is more distributed and warrants for reasoning are based on the physical system itself.

Although occasionally groups take up the engineering world activity from the outset, the most common observation is that teams oscillate between figured worlds as they negotiate a path forward, often beginning in school world and shifting to engineering world when they hit a snag. The social process of this pattern is interesting, with a dominant student initiating activity in school world, and engineering world approaches proposed somewhat later by a non-dominant student. We have observed that challenges to consider engineering world issues are often reasoned away initially with school world reasoning by the dominant student, until another student joins the push to enter engineering world. As school world reasoning becomes less and less convincing to the group, activity shifts to sense-making grounded in the physical system and real-world consequences of engineering decisions. In another paper in this conference [7], we discuss the role of "glorious confusion" in these activities where "students engage in these complex and realistic problems in ways which afford them the opportunities to participate in sociotechnical disciplinary practices, to operationalize the big ideas from their current and other courses, and to leverage their knowledge and experiences from the real world." Since shifts from engineering world to school world draw upon reasoning processes that are less transferrable to engineering practice, we are focusing on the way activities can be designed and instructional support framed in ways that students collaboratively engage with one another in realistic ways.

School Community

We have developed a survey instrument to assess student perceptions of climate, and delivered the survey for the second year collecting 500 responses. We have taken the feedback and integrated the perspectives with the data from focus groups [16 focus groups (2-5 participants), 6 individual interviews (60 min.)], senior exit interviews, and international student listening sessions.

The climate survey revealed that while students perceived the School climate as generally welcoming, students from all social identity groups rated the climate as significantly more welcoming for students from dominant (white, male, US-born) than nondominant (all other social identities) groups. Both quantitative survey analysis and qualitative analysis of open-ended responses on the survey highlighted the importance of peer relations in students' perceptions of climate and engineering identity [8]. In the Fall Faculty Retreat, we discussed this integrated feedback with the faculty. We will continue to embed the climate survey into the standard operations of the assessment committee.

We are soliciting ideas from faculty and staff to improve School and College policies, norms and practices toward a more just workplace. Faculty and staff will opt in to participate on projects they are interested in, led by faculty who have participated in the 60 hour professional development around difference, power and discrimination.

Our assessments have identified that international students experience the culture of CBEE less positively than domestic students. To address this challenge, in the final two years of the project we plan to work with students and staff with competencies in international student experiences to identify interventions and support mechanisms to benefit international students. Importantly, we need to also educate and align School administration towards the importance of this issue.

Challenges

Leadership changes have made consistent progress more difficult. The 5-year RED grant requires the PI to be the school or department head, but administrator turnover is often more rapid than that. In our case, we have changed leadership 3 times in four years.

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