

Sustainable Educational Innovation Through Engaged Pedagogy and Organizational Change

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Abstract—This Research-to-Practice Work-in-Progress Paper presents a midway report on a change initiative underway in the College of Computing and Informatics (CCI) at UNC Charlotte. Comprised of approximately 100 faculty members and nearing 2,000 undergraduate majors, CCI was awarded a 5-year, \$2 million grant from the National Science Foundation in 2015 to revolutionize computer science education at the collegiate level. This initiative, which seeks to *simultaneously* achieve both pedagogical and organizational change, is built upon a foundation of educational innovation through engaged teaching practices. To sustain educational innovation in CCI beyond the funded scope of the project, pedagogical change is thus strategically embedded in CCI's organizational structure through a 3-stage model of faculty adoption, redesigned student course evaluations, and realigned values in the reappointment, promotion, and tenure process. By recognizing that sustained organizational change takes root when there is concurrent buy-in from organizational members—both bottom-up and top-down—this reform initiative seeks to embed two-pronged change not only via educational innovation (pedagogical change), but also in the day-to-day practices, policies, and physical environment of the College itself (organizational change).

Keywords—computer science education; pedagogical change; organizational change; engaged teaching practices

I. INTRODUCTION

Collegiate-level computer science education (CSEd) faces challenges and opportunities as it seeks to reconcile its “theoretical, scientific, and engineering traditions” [1] with the uncertainties and unknowns of a 21st century global economy. The exponentially rapid development of new technologies in tandem with the displacement and disruption of old technologies, the global urgency to diversify a tech-savvy workforce that remains stubbornly homogeneous, and the unknown jobs of tomorrow shape a “moving target” of expectations of what CSEd was, is, and should be for educators, practitioners, and students.

At the same time, a reassertion of hegemonic systems of domination is being seen across the globe, destabilizing the fragile foundation underlying human rights and social progress [2]. Efforts to eradicate the effects of prejudice and discrimination on race/ethnicity, gender, immigrant status,

ability, sexuality, religion, and socioeconomic status are threatened by the unraveling of civil rights policy and legislation that has long sought to dismantle inequity in employment and education, particularly in the United States. This dramatic shift in the overarching social-political-economic environment should alarm CSEd researchers and practitioners, for it pushes back against equality, equity, and justice gains in CSEd by seeking to maintain old, dominant paradigms that sustain the status quo. Educational reform is laborious even when conditions are favorable. Given these overarching hostile conditions, we propose that sustainable educational innovation is achievable when both pedagogical change and organizational change are woven into CSEd institutions and programs themselves, thus becoming endemic to these institutions and programs throughout the change process.

Academic disciplines tend to be static institutions that are resistant to change, particularly as the larger institutional practices of their surrounding universities and academic communities reinforce norms of constancy and consistency [3]. Although computer science is a relatively young discipline in comparison to many of its peers, it too reflects these norms, as demonstrated by the adoption of common academic practices such as “competitive ratings and rankings, acceptances and rejections, and authoritarian and hierarchical structures – departmental, college, and university-wide” [3, p. 292]. These norms and practices are also frequently present in the college classroom via traditional teaching practices that skew towards “sage-on-the-stage” lecture formats, a teaching technique that maintains historical patterns of power and inequity in the transfer of knowledge [4].

Over the past several years, there have been many laudable change initiatives undertaken by researchers and practitioners to transform CSEd. For example, a cursory look through the conference proceedings of Frontiers in Education (FIE) and the Special Interest Group on Computer Science Education (SIGCSE) demonstrates the vast commitment and motivation CSEd researchers and practitioners have for the transformation of CSEd. While we commend our colleagues for their efforts, it is our observation that these efforts tend to be undertaken by an individual instructor in a singular classroom, inadvertently stunting change at scale due to the individual nature of the

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effort and focus, and thus not achieving widespread, disciplinary reform. Therefore, we argue that these laudable, well-intentioned reform efforts inevitably become nested in the overarching social-political-economic environment that ultimately desires to maintain historic systems of domination, thus “nothing really changes” substantively. To overcome this perpetuation of the status quo and achieve sustainable reform at the larger institutional level, we propose that change efforts must occur *simultaneously* at both the pedagogical and organizational levels for widespread, scalable propagation in the computing discipline. The Connected Learner Project (CLP), a change initiative in the College of Computing and Informatics (CCI) at UNC Charlotte, is a developing model for sustainable educational innovation through simultaneous pedagogical and organizational change. This research-to-practice work-in-progress paper provides a midway report of the CLP change model in process by summarizing the organizational context of the Project, our mechanism of pedagogical change, and how these changes will be systemically sustained in the College.

II. THE ORGANIZATIONAL CONTEXT

A. The University of North Carolina at Charlotte

The University of North Carolina at Charlotte is a large, urban research university in the southeastern United States, serving a diverse population of nearly 30,000 students. UNC Charlotte is a minority-serving institution.

B. The College of Computing and Informatics

1) *Faculty*: CCI is comprised of three departments: Bioinformatics and Genomics, Computer Science, and Software and Information Systems. Across the departments, CCI has approximately 100 faculty, with faculty membership fairly balanced between tenure-track research faculty (i.e., assistant, associate, and full professors) and nontenure-track teaching faculty (i.e., lecturers, teaching professors, and adjuncts). In 2016, CCI implemented a unified undergraduate curriculum across the three departments: students in the Computer Science major graduate with either a bachelor of science among seven concentrations (e.g., cybersecurity; data science; AI, robotics, and gaming) or a bachelor of arts degree among four concentrations (e.g., human-computer interaction; financial services; information technology). Teaching faculty typically teach CCI’s “core courses” that students take in the first two years of the undergraduate program, while research faculty typically teach CCI’s upper-level courses that students take in the later years of the undergraduate program. With a robust graduate program at both the masters and doctoral levels, graduate teaching assistants are widely deployed throughout all CCI courses.

2) *Physical Space*: CCI’s three departments are housed in two academic buildings. In Fall 2016, CCI opened five renovated classrooms that were redesigned to foster interactive, engaged teaching and learning. Traditional, lecture-style desks were replaced by movable, reconfigurable chairs and tables. Multiple viewing screens, dry erase surfaces, and ample electric receptacles for students’ laptops and tablets were also incorporated. In addition to classroom renovations, CCI also

renovated existing spaces and created new spaces for students to study together and socialize in various locations throughout the College. Collegiate spaces that foster social and academic interaction have been shown “to provide needed support and enhance feelings of college belonging, college identity, and college competence” among students [5, p. 20].

3) *Undergraduate Student Profile*: With nearly 2,000 undergraduate students, CCI is the largest undergraduate computer science program in the UNC system and continues to experience high growth in enrollment [6]. Because of UNC Charlotte’s metropolitan location, a high percentage of the overall student body is comprised of commuting students and/or students who work. Over 70% of CCI’s students live off campus and 39% are over 24 years old. In Fall 2017, 74% of CCI’s undergraduate students applied for financial aid. A survey study showed that CCI’s students have significantly more federal student loans, less scholarship support, and less family support than a comparison peer group [7]. Approximately 16% of CCI’s students are women and approximately 25% are underrepresented minority students. In comparison to peer institutions, CCI also has a high percentage of external transfer students from community colleges (~30%).

Like many CSEd programs, CCI has struggled with attraction, retention, and graduation rates, particularly among women and students of color [8][9]. Historical analysis and evaluations within the College itself have suggested that the barriers faced by women and students of color in CCI are due in large part to a historical CS curriculum designed for incoming undergraduates with substantial computing exposure and experience, privileging those students with prior access to computer equipment and training in high school and/or their homes and communities. Our introductory CS courses were designed to favor students with previous computing expertise, precluding students whose access to computing is delayed until they enter college. Unfortunately, our historic curriculum along with a heavy teaching norm of traditional lecture exacerbated the ramifications of this delay, effectively telling those students with little prior computing experience that they “don’t belong here” in CCI. It was within this humbling context that some of CCI’s faculty and administration members recognized an urgent need to make substantive pedagogical and organizational changes locally in CCI.

III. THE CONNECTED LEARNER PROJECT

The formal opportunity for CCI to attempt large-scale change coincided with a new line of funding from the National Science Foundation (NSF). In 2015, NSF introduced *RED: REvolutionizing engineering and computer science Departments* under their Improving Undergraduate STEM Education (IUSE) program and Professional Formation of Engineers (PFE) initiative. In 2015, CCI’s Connected Learner Project (CLP) was awarded a 5-year, \$2 million grant by NSF that fittingly:

“enables engineering and computer science departments to lead the nation by successfully achieving significant sustainable changes necessary to overcome longstanding issues in their undergraduate programs and educate inclusive communities of engineering and computer science students prepared to solve 21st-century challenges” [10].

To remove the barriers to entry in CCI and prepare an increasingly diverse student body to solve 21st-century challenges, the CLP is designed to reorient computing pedagogy by refocusing student learning on connection to their peers, their purpose, and their profession. Our vision is to create and sustain a transformational learning environment in which students enter the undergraduate program with an interest in computing and leave the undergraduate program with an affinity identity as a computing professional [11]. To achieve this vision, the CLP employs a systemic approach to implementing simultaneous pedagogical and organizational change through the adoption of new teaching practices that gradually shift CCI's historical norms and organizational practices to not only reshape CCI, but to also challenge the overarching status quo in CSEd. These new teaching practices—which align with bell hooks' theory of engaged pedagogy to transgress the historic structures of domination [4]—thus act as the mechanism of educational innovation in CCI, integrating educational innovation both within teaching practice *and* the culture of CCI itself.

Thus, for the past several years, the CLP has been creating sustainable change through educational innovations designed to (re)engage students and faculty. Specific innovations include: (1) the development and deployment of “lightweight” teams to foster pedagogy based on peer learning [*connection to peers*] [12]; (2) the development of service learning opportunities for students to engage in meaningful learning activities that demonstrate how computing can solve social problems [*connection to purpose*], and (3) the establishment of ongoing partnerships between industry and CCI to engage students through the integration of contemporary, “real-world” problem-solving experiences within the CCI curriculum [*connection to profession*].

It is important to recognize that the efforts of the CLP are not occurring in a vacuum, as other changes and developments are occurring in and around CCI that affect both student and faculty experiences and outcomes. For example, the adoption of a unified curriculum in 2016 was not due to the efforts of the CLP, but generated from related reform efforts in CCI. Another significant event has been a change in CCI's executive leadership, with a new Dean appointed in Fall 2017. Additionally, CCI faculty, staff, and students will be affected in the Fall 2018 semester when UNC Charlotte partially implements 50-minute class periods (whereby the longstanding norm has been 75 minutes), significantly changing the structure of class schedules across the entire campus. These structural changes that are technically outside of the control or scope of the CLP demonstrate the give-and-take nature of change within complex, institutional systems that make causal findings and results difficult to definitively attribute to a specific intervention. While we can measure myriad phenomena in CCI, we can never truly know if a certain outcome—such as improved retention or graduation rates—was the direct result of a specific intervention.

That said, the foundation of the CLP is rooted in a philosophy of educational innovation. As stated earlier, norms and practices in the college classroom skew towards “sage-on-the-stage” lecture formats [13], a teaching technique that arguably maintain historical patterns of power and inequity in

the transfer of knowledge [4]. The widespread use of lecture in the academy is a historically standardized practice that has been widely accepted, embraced, and rewarded for centuries, so while we argue that lectures can function as a mechanism of domination and power, we do not believe that this is done with deliberate malice. Collegiate-level faculty have long lamented the lack of pedagogical training during their graduate studies [14], and when thrust into the professoriate, simply repeat what they know and experienced as students themselves. Thus, over time, teaching via lecture has become institutionalized and normalized into the everyday practices of the academy.

We posit that while not ill-intentioned, the dominant use of lectures is not serving today's computing students, particularly women and students of color. Lectures often fail to *engage* students in course material, hindering an array of positive student outcomes [2]. In an era where troves of information are widely available via the internet, professors are no longer gatekeepers to the vast stores of knowledge of an academic discipline. Teaching students to understand, process, and critically leverage that information for their learning and professional development is a more effective means of preparing students for the unknown (computing) jobs of the 21st-century global economy [15][16].

As sustainable, systemic change is more likely to be successful when it is driven up from the bottom, rather than forced down from the top [17], the CLP team created a long-term plan for “faculty buy-in” at the inception of the Project. Because we believe strongly in the tenet of academic freedom, our efforts are not directed at telling faculty they must change how they teach; rather, we hope that by demonstrating the positive effects of engaged pedagogical techniques, they will be motivated to try new teaching practices that not only foster student engagement, but faculty engagement as well. Prior to the CLP grant being awarded in 2015, for example, a small cadre of CCI's faculty had already been trying engaged teaching practices, particularly in introductory CS courses. While not a panacea to CSEd's barriers and challenges, these faculty saw positive effects on student outcomes from their efforts [18]. Additionally, the faculty themselves felt more engaged in the classroom and in their interactions with students. Thus, a seed was planted in CCI to consider implementing engaged teaching practices on a larger scale in the College. While funding is not required for any CSEd institution or program to adopt engaged teaching practices and pursue scalable reform, the CLP grant served as a catalyst to support these efforts by providing stipends to faculty engaging in adopting engaged teaching techniques.

With the formal funding support of the 5-year Project, the CLP team designed and implemented a 3-stage strategic model for simultaneous pedagogical and organizational change (see Table I). The first stage, faculty adoption of engaged teaching practices, was implemented in Year 1 of the grant and is ongoing. The second stage, redesign of student course evaluations, is currently in process as the Project transitions from Year 3 to Year 4. The third stage, review of the reappointment, promotion, and tenure process, will be forthcoming in Years 4 and 5 of the Project.

TABLE I. CONNECTED LEARNER CHANGE MODEL

Stages of Change	Activities and Goals
Stage 1: Faculty Adoption (Implemented / Ongoing)	<ol style="list-style-type: none"> 1. Summer Teaching Institutes 2. Engaged Pedagogical Practice 3. Annually increase growth by ~10% <ul style="list-style-type: none"> - 2016: 15% faculty participation - 2017: 25% faculty participation - 2018: 35% faculty participation - 2020: Goal to achieve +50% faculty participation by end of funding period
Stage 2: Student Course Evaluations (In Process)	<ol style="list-style-type: none"> 1. Currently redesigning for implementation AY 2018-2019 (anticipated) 2. Shift emphasis from evaluation of instructor to evaluation of teaching and learning 3. Redesign to address bias, thus enstructuring diversity values in recurring, everyday processes of the organization
Stage 3: RPT Process (Forthcoming)	<ol style="list-style-type: none"> 1. Course evaluations are key component of RPT process of the organization 2. Redesigned evaluations will strategically send crucial signal to all members that engaged pedagogy matters beyond espoused values and overarching environmental pressures to maintain historic systems of domination

A. Stage 1: Faculty Adoption

To jump start faculty adoption of engaged teaching practices, an initial cohort of six CCI faculty members were paid \$8,000 stipends in Year 1 of the CLP to participate in CCI's Inaugural Summer Institute. During this Institute, the faculty cohort was introduced to the concept of engaged teaching practices (e.g., active learning, clicker quizzes, lightweight teams, video creation/video alternatives to lecture, strategic use of learning management systems, student reflection). By participating in the Institute, faculty agreed to implement two engaged teaching practices in one of their courses the following fall semester. At no time was an expectation placed on the faculty to fully revamp and redesign their courses—we simply asked them to try two engaged teaching techniques. Throughout the summer, several of the CLP team members provided additional support and engaged teaching resources to help the cohort prepare their courses. The funded cohort model of faculty adoption was repeated in Year 2 of the CLP, with the new cohort expanded to an additional 11 faculty members. The current cohort for Year 3 has 10 new members, two of whom are doctoral students with teaching responsibilities. As we slowly fund new cohorts of faculty each successive year of the CLP—across job ranks and classifications—we aim to annually increase adoption among CCI faculty by about 10%, with an overarching goal of achieving over 50% adoption by 2020.

B. Stage 2: Student Course Evaluations

While faculty adoption is a critical component of the *pedagogical* change process, long-term adoption of engaged teaching practices is more likely to be sustained in CCI if engaged pedagogy becomes part of the *organizational* change

process, whereby engaged pedagogy is an explicit organizational value and part of routine organizational practice. One such strategy for sustaining educational innovation in the organization is through a proposed redesign of student course evaluations.

Institutionalized student course evaluations across the academy are frequently criticized, for they are often designed to evaluate the instructor, rather than evaluate teaching and learning [19]. Student course evaluations carry a heavy weight in faculty reviews and promotion [20][21][22], despite their propensity to elicit sexist and racist bias towards instructors from students [20][22][23]. The CLP team is currently redesigning CCI's student course evaluations to buffer against bias and serve as a better assessment of teaching and learning. While the CLP is jump-starting this redesign, adoption of new student course evaluations will require discussion and acceptance from CCI faculty and administration.

C. Stage 3: Reappointment, Promotion, and Tenure Process

As with student course evaluations, the reappointment, promotion, and tenure (RPT) process in CCI is a part of routine organizational practice. Student course evaluations often carry a significant weight in the RPT process. If the proposed redesign of student course evaluations is successfully implemented, this significant change thus sends a crucial signal to all organizational members that engaged pedagogy matters.

IV. CONCLUSION

As this paper is a midway report of a multi-year project, Year 3 has brought forth a period of reflection and reexamination for the Connected Learner Project team. For example, while we feel confident that we have identified what successful engaged pedagogy entails in the early years of CCI's computing curriculum, we are currently defining what engaged pedagogy means in our upper division courses. These understandings are critical to the Stage 2 redesign of student course evaluations. Throughout the Project, we have solicited input from both faculty and students on the concurrent reform efforts in CCI. This realignment of expectations and efforts are appropriate at the midway point of the change initiative, as organizational change efforts often require periods of realignment to better serve the changing needs of CCI's varied stakeholders—students, faculty, staff, administration, external partners. By recognizing that sustained organizational change takes root when there is concurrent buy-in from organizational members—both bottom-up and top-down—this reform initiative seeks to embed two-pronged change not only via educational innovation (pedagogical change), but also in the day-to-day practices, policies, and physical environment of the College itself (organizational change). Midway evaluation follows several distinct phases; the primary purpose of this paper is to report on efforts to-date with our peers in the CSED community. The resulting ongoing conversation among CSED researchers and practitioners further informs the future aspects of the Connected Learner Project and helps promote a pedagogical change climate of learning and transparency.

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