Broadening Participation in Computing via Professional Development for Community College CS/IT Faculty

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ABSTRACT

This paper describes the creation of a virtual, interactive professional development course to build the capacity of community college faculty to recruit and retain women and underrepresented minorities in computing programs. The project was designed in response to community college faculty reporting need for practical methods to broaden participation in their programs and their feelings of isolation from like-minded faculty. The 12-session prototype has been piloted with eight community college faculty. The finalized PD will be available as free, standalone web-based modules. The course includes instruction on research-based practices for recruiting and retaining women and underrepresented minorities in computing. Evaluation mechanisms are developed to assess the impacts of the PD on faculty attitudes and teaching practices, and the effect of changed practices on introductory computing students' engagement and persistence. Here we report preliminary findings from interviews. The project outputs will include polished online content modules, validated student survey instruments, a classroom observation protocol, and student and faculty interview instruments.

CCS CONCEPTS

• Social and professional topics~Computing education

KEYWORDS

Broadening participation in computing; Gender; Community college; Faculty professional development; Longitudinal research

1 THE IMPORTANCE OF COMMUNITY COLLEGES TO COMPUTING EDUCATION

Community colleges are an "open access point to higher education" for many Americans [7], enrolling 30% of all U.S. undergraduates in the spring of 2017 [8]. Community colleges are also playing an increasingly important role in computing education. In the 2017 academic year, computer science and information technology (CS/IT) majors were second only to health professions as the most popular community college STEM major [8]. In 2015, almost 37,000 CS/IT associates degrees were awarded, a 28% increase from 2007 [8]. Since CS/IT students who intend to transfer to a 4-year college often do not complete an associate's degree before transferring, this statistic likely underestimates the impact of community colleges [9]. To put this in perspective, it is estimated that between 40-50% of students receiving a bachelor's degree in science or engineering have taken at least one class at a community college [13,11]. With growing enrollment pressures in bachelor's computing programs and the increasing cost of higher education, community colleges are likely to play an increasingly important role in computing education.

1.1 Broadening Participation

The unique mission of inclusion and open-access of community colleges also makes them a crucial point of intervention in the effort to broaden participation in computing. Students from racial/ethnic groups that are traditionally underrepresented in computing, as well as students who are first in their family to attend college, are better represented at community college than at four-year colleges [2]. For example, more Hispanic students are attending community colleges (52%) than 4-year schools (48%). And while women are outpacing men in college enrollment across the board (representing 56% of all undergraduates) the pattern is even more striking at community colleges where women comprise 61% of all students. That said, in 2015 women accounted for only 21% of associate degrees in computing, down 4% from 2008 [5]. Community colleges—like 4-year institutions—are struggling to attract and keep women in their computing programs.

1.2 The Role of Faculty

Given the crucial role that community colleges play, it is important that faculty are empowered to provide a quality educational experience to their students, including being sensitive and responsive to student differences. Research on the

role of community college instructors suggests they are crucial for building and maintaining students' interest and persistence in CS/IT [6] by providing inspiration [14], modelling respectful treatment [1], providing effective encouragement and advice, and through their availability outside of class [10]. These effects are especially salient for non-traditional students, including older women and students who are first in their family to attend college [6, 14]. Teaching at a community college may also require a greater level of teaching expertise and skill because of the diverse backgrounds and wide range of academic preparation of community college students [3].

Unfortunately, community college faculty also tend to have access to fewer resources, have higher teaching loads, and need to be more responsive to the changing needs of industry than their colleagues at four-year institutions [4]. In addition, while faculty may be experts in their technical fields, they tend to have little formal training in effective pedagogy and ways to recruit and retain a diverse student body.

1.3 The Need for Faculty Professional Development to Broaden Participation

Clearly, community colleges—and the faculty teaching in those computing programs—hold great potential to broaden participation in computing education because of their more diverse student populations and closer faculty-to-student interaction. To make good on this promise, community college faculty need help designing and implementing effective and practical recruiting and retention strategies. This includes improving student experiences in those crucial introductory courses with evidence-based pedagogical practices for retaining women and underrepresented minorities in computing. This is why we developed EngageIT. The goal of the current paper is to introduce readers to the project and to offer insight into the development and implementation of professional development programs in the community college (CC) context.

2 THE ENGAGEIT PROJECT

We are finishing the second year of a three-year National Science Foundation-funded project to prototype a high quality, easy-to-access professional development (PD) to build the capacity of CC faculty to recruit and retain underrepresented students, including women and minorities, in their programs. This prototype sets the ground for building out an interactive online professional development course with several stand-alone modules. The ultimate end-product will be available for free to all postsecondary faculty through the National Center for Women & Information Technology (NCWIT), a well-known source of research-based materials for broadening participation in computing.

We have recently completed testing of the prototype PD with two groups of community college faculty ("cohort 1" and "cohort 2"). We are assessing the effectiveness of the PD at both the faculty and student levels. If the PD is effective—in that faculty internalize the information and effectively implement reforms in both recruiting and retaining students—we should see increased levels of interest and confidence in computing for women and minority students enrolled in the targeted courses after (as compared to before) the instructor's participation in the PD. Differences in initial starting levels for students in semesters before and after their instructors' exposure to the PD are measured via surveys administered during class, early in the term and late in the term. In the long term, we expect increases in the participation of women and other underrepresented students in the targeted programs. Analysis of the data is ongoing. In this paper, we describe the development of the program with two faculty cohorts and share some preliminary findings.

2.1. From Development to Implementation

2.1.1 Developing the PD. The project team (two research scientists from NCWIT, a curriculum developer, a research assistant, and a project manager) developed a 12-session, weekly PD curriculum with guidance from an advisory board comprised largely of community college faculty and administrators with extensive experience in broadening participation in computing. The curriculum is based on NCWIT's existing research-based resources and practices, and enlisted NCWIT social scientists and other experts in the field as guest speakers.

2.1.2 Recruitment of Faculty. We piloted the initial version of the PD curriculum with three community college CS/IT faculty in the spring of 2016. All participants—two white women and one Hispanic woman—were department heads and each had more than 18 years of teaching experience. Two had some experience working in broadening participation in computing. We selected more experienced faculty for the first cohort with the idea that they would be able to provide well-informed feedback on the content of the professional development and serve as expert informants on their programs and schools.

The second cohort consisted of three white men, one southeast Asian man, and one white woman. All had between four and eight years of teaching experience, and seven of the eight had industry experience. While two members of cohort 2 are the only FTE in their department, the median department size for participants in both cohorts was 4 FTEs. Across the two cohorts, participants were drawn from eight geographically dispersed states: Maryland, Tennessee, Ohio, Colorado, California, Oregon, Washington, and Hawaii.

2.1.3 Initial Implementation. Each faculty member worked with the project's research director to identify a course where, based on their understanding of their student body and their program, students tend to decide whether to continue or to drop out of a computing track. We refer to this course as the faculty member's "Target Course." The faculty focused their retention efforts on this course.

Based on our earlier work with CC faculty, we knew that they lack both the time and resources to travel for extensive in-person PD. We also knew faculty valued hearing from other CC faculty and having opportunities to reflect together in real time. Given this, and keeping an eye on our goal to scale the program, we designed the PD to be delivered in weekly one-hour synchronous video-conferencing sessions supported by an online course management system which hosted background reading

and a discussion board. There were two six-week sessions, with a break in March to accommodate spring breaks. To facilitate gathering of feedback on the prototype PD from participants and our advisory board, we met face-to-face at a day-long meeting in May in years one and two of the project.

Each participating instructor created recruitment and retention plans for their programs and Target Courses. Their plans included at least one recruitment strategy to employ in the coming year and one change to their Target Course to help engage and retain more women and minorities. The advisory board and the project team provided feedback on the plans prior to implementation.

2.1.4 Assessing Program Impact. An important part of this project is the development of new assessment methods. Since the ultimate impact of the PD is, hopefully, on students, we have developed both instructor- and student-level instruments. These include surveys of students in each participating faculty member's targeted course; interview scripts to use with a subset of students from each faculty member's Target Course and with faculty before the PD, during the PD, and in subsequent semesters; observation protocols to assess the interactions among faculty and their attitudes during the PD and to assess the teaching practices of individual faculty in their targeted course; and rubrics for evaluation of faculty recruitment and retention plans. We also have participating instructors collect program- and course-level data on the participation of women and minorities compared to the overall student body at their college.

2.1.5 Data Collection. Each term, we have surveyed students in each faculty member's Target Course both early and late in the course. These data serve as the baseline student-level data and will be compared to student-level data in the same course in semesters after the instructor completes the PD. The surveys measure interest in and intent to persist in computing as well as confidence in computing (and in comparative domains) at both time points. On the late-course survey, we also ask students about classroom climate and the approachability and support offered by the instructor. To control for differences between semesters and students, in the early-course survey we also included questions about prior computing experience, external social support, and key demographics, including gender, race/ethnicity, and age.

The research director conducts a series of interviews with participating instructors each year. The interviews provide insight into the structure of participants' course and programs, the types of students they typically teach and at their college overall, their pedagogical and curricular approaches to teaching their Target Courses, and both supports for and challenges to changing their pedagogical practices and to implementing strategies for broadening participation in computing. In addition, to better understand potential differences among faculty, we collect information about their education and training, and their pathways into teaching. While we don't ask explicitly, in our analysis we code for attitudes and behavior related to gender and racial stereotypes and beliefs. In addition to faculty interviews,

we have interviewed 21 students (11 women and 10 men) from across the institutions, some of them multiple times.

2.2 Honing the Program and Evaluation Mechanisms

After the completion of the pilot PD in May of 2016, the team used

Figure 1 Updated 2017 PD Modules

feedback from the advisory board, cohort 1 faculty, and internal evaluations to develop the next iteration of the PD. We changed both the structure and content. First, we more clearly "flipped" the instruction so that discussion and other interactive activities were prioritized during the weekly video-conference meetings. All presentations were recorded ahead of time and participants viewed them prior to the weekly calls and read assigned materials. The course continued to make use of a free Learning Management System to host resources, announcements, and a discussion board.

Second, we adjusted the topics and their sequencing particularly to emphasize more clearly our focus on broadening participation. In the first round of the PD, we had found that participants tended to drift toward more general discussion of pedagogy and recruiting, and to lose the focus on broadening participation. We also changed the process of creating and reviewing recruitment and retention plans to reduce faculty burden and help ensure the plans were useful to the faculty as actionable plans rather than simply a project exercise.

In the second year of data collection, we significantly modified the student surveys based on review of cohort 1 data. To maximize response rates, we enlisted help from colleagues across the country to administer the early-course survey at a meeting of each Cohort 2 target course. The survey administrators also conducted formal observations of the class during these visits. We are comparing these observations with student survey and interview data, and faculty interview data.

3 IMPACTS: PRELIMINARY OBSERVATIONS

To understand the overall impact of our project, at the end of this academic year we will complete collection of student-level data. We will also evaluate student academic progress and pathways by matching survey data to National Student Clearinghouse data. Collection of student-level data is in mid-stream with the second cohort of faculty just beginning their implementation semester. To date, the most informative information about the impact of the PD comes from our interviews with cohort faculty and classroom and PD observations.

In cohort 1, two participants made notable strides in both recruiting and retention over the year since finishing the PD. The third participant did not and has resigned her position at the community college for unrelated reasons. Cohort 2 participants have all developed recruitment and retention plans specific to their institution and target course, and these plans have been assessed by our Advisory Board. Pulling from faculty-level data from both cohorts, we offer the following insights on aspects of the PD that may be of interest to others developing similar programs.

3.1 Community is Important

The participating faculty clearly relish the time to talk with other CC faculty even if only via video-conferencing. In the midpoint evaluation, all eight participants commented on the value of the discussions. As one participant noted, "It's enriching to hear the experiences of my peers in other schools, since I don't often get to hear those." Indeed, many CC faculty in computing are isolated in their colleges; for example, four of the eight participants are the only faculty in their programs or the only ones in their program teaching introductory computer science courses. A comment from one such faculty member about what they most appreciated about the PD is illustrative: "The conversations! As a department of one, I don't get a whole lot of opportunities to compare notes and practices."

3.2 Reframing What It Means to Recruit

Initially, participants tended to think of "recruiting" in the larger institutional sense: as something you do to get more students to come to your institution. Not surprising, many faculty felt this was out of their purview and too time consuming. However, in the PD participants were introduced to the concept of "in-reach" where the goal is to recruit *from* one's institution rather than *for* one's institution. This is especially productive in the community college setting where women are clearly the institutional majority and many are concentrated in health sciences fields, programs that are often impacted by high enrollments. Aligning student understanding to ideas that may be appealing to health sciences students (e.g., you can help others, work with technology, make good money in a field with lots of jobs) is a powerful in-reach technique.

Once participants made the conceptual shift from outreach to in-reach, they could identify promising opportunities within their colleges (i.e., doing presentations in required feeder courses). They were also able to identify existing actors (e.g., advisors) that could be trained to do both in-reach and outreach for them. Seven faculty members are implementing some form of in-reach, including six who are reaching out to students in key feeder courses through presentations and materials. Three faculty members are using NCWIT's resources to train advisors and recruiters about their CS transfer programs and about computing in general. Others have obtained additional grant funding to make marketing brochures to reframe how they are describing their programs to prospective students. So rather than feeling like they need to do it alone, they now recognize they can supply others with information to do the work on their programs' behalf.

3.3 Changing Teaching Practices Takes Time and Support

Implementation of new teaching practices was inconsistent and slow for cohort 1 participants. One cohort 1 faculty member introduced pair programming in her course post-PD, but, perhaps unsurprisingly, full implementation didn't happen until the second semester. She is seeing improvements in pass rates and student engagement. The second cohort 1 participant was already using many of the recommended engagement practices and her students evidenced some of the highest levels of engagement even before the PD. The final cohort 1 member did not implement an approved practice but this is likely linked to her subsequent resignation. Cohort 2 participants had their first opportunity to implement their plans in the fall 2017 semester. One participant from cohort 2 was so excited to try some new assignments from EngageCSEdu that he implemented them in his course even before completing the PD. Six of the remaining seven participants have integrated some form of collaborative learning in their Target Course, but observation and interviews reveal that may be incomplete or ineffective implementation for some participants. Three participants are changing how they present some material to address misconceptions about the field of computing and three are updating assignments to make them more relevant and meaningful to their students.

Interview and observation data indicate that participants have increased their awareness of pedagogical techniques for broadening participation in computing. But previous research suggests that knowledge alone does not necessarily translate into changes in teaching practice [5]. The addition of a supportive community (via the cohorts) may encourage and support change in teaching practices. We do expect that whatever change happens will occur incrementally over several semesters.

3.4 The Power of Data to Inform and Reframe

All participants were initially unsure of how to assess the impact of their initiatives. In the second round of the PD, we strengthened the unit on evaluation. We have found that given even rudimentary training on the philosophy and method of program evaluation, most participants became enthusiastic collectors and users of data. They learned the usefulness, for instance, of not only surveying students after each intervention

(e.g., pair programming) but also collecting institutional data to establish a baseline comparison (e.g., pass/fail rates, percentage of women in college vs CS/IT department vs Introduction to Computing class). We believe that this aspect of the project has been successful because it leverages computing instructors' professional interest and training in data and data analysis. With an improved understanding of how and when to ask the right evaluation questions, CS/IT faculty are more equipped than most to do this kind of work. Indeed, some participants have become "evangelical" about evaluation.

But interviews and observations of the PD revealed a subtler impact of data. Having low numbers of women and minorities in computing courses has become so normative that instructors have trouble even envisioning a different scenario. Even as they work to broaden participation, many simply took it for granted that men will dominate their classrooms (both numerically and culturally). Data is helping to break this blind spot. For example, faculty were guided to compare the demographics of their program to the demographics of their college and to other technical programs (such as medical technology). With this, these other, more diverse, students started to "come into focus" as potential computing students. Some faculty, then, could begin to envision a different sea of faces in their computing courses.

4 DISCUSSION AND NEXT STEPS

A major challenge to doing this kind of work is overcoming the belief among faculty that responsibility for diversity lies elsewhere. Faculty, especially perhaps community college faculty, often feel powerless to affect change. Most faculty also lack knowledge of practical strategies for recruitment and retention. We developed the EngageIT project to both equip faculty with these strategies and to provide a community of other instructors and experts to support their initiatives. The ultimate goal of this project is to develop a multimedia online professional development course based on the pilot curriculum that will be publically available to both CC and four-year faculty.

The experiences of our participants have underscored the importance of giving faculty tools to use to change their practices, but also the time to reflect and the community to support them. This finding has convinced us of the need to develop a practical implementation guide to accompany the standalone modules and/or to offer periodic webinars.

While our findings are preliminary, we have seen the most progress across participants in terms of understanding and adoption of recruiting initiatives, especially those that are "close to home," i.e., in-reach efforts. Still, some remain unsure how they can influence their college's outreach activities and messaging about computing.

The implementation of retention strategies within classrooms is still too preliminary to draw firm conclusions. We see that implementing these strategies appears more iterative and to take longer than recruitment initiatives. Cohort 1 faculty have also noted challenges with how to influence the teaching practices of their departmental colleagues. On one hand, this is a real challenge; on the other hand, that they see this as important is a positive sign.

Developing, implementing, and distributing faculty professional development to improve recruitment and retention of community college students can potentially impact hundreds of thousands of students. Of course, the ultimate test of the project's effectiveness is its impact on student engagement and retention in computing. Future comparisons of pre-PD students with post-PD students will offer insights into mid-range effects, while tracking student persistence in computing will give us long-term effects.

Finally, while the implementation of the PD was geared toward community college faculty, the delivered "lessons" are relevant for all faculty interested in broadening participation. Largescale dissemination of the final PD and associated research findings will be facilitated by NCWIT's national and technological infrastructure.

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