Meeting the Graduate 10K+ Challenge: Enhancing the Climate for Persistence and Success in Engineering (ECliPSE)

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Abstract

The aim of our project is to significantly increase 1st and 2nd year retention rates and graduation rates in engineering and computer science at our institution. Our work has sought to re-form the undergraduate student experience in our college into one with a more welcoming climate, promoting strong faculty-student interactions and best practices in engineering education. In particular, we have focused on a multi-pronged approach to improving the quality of instruction and academic advising through a synergistic series of activities including: a well-supported faculty development program in teaching; the redesign of gateway courses and implementation of innovative and active learning pedagogies; guidance for faculty in their advising practice; and extension of previously tested first year academic support into the second year. Over the course of this project, the two-year retention rate in the College of Engineering and Computer Science at Syracuse University has increased from 63% to 80%. The four and six-year graduation rates have also increased by 10 percentage points each. Student performance has improved significantly in gateway courses taught by faculty who have participated in more intensive faculty development programs (e.g. multi-day workshops). Successful academic support services, such as our Academic Excellence Workshop (AEW) courses, have been extended to almost all 2nd year courses in the college and students who participate in two or more AEW courses are retained in the college at a rate of nearly 100%.

Background

Numerous studies have attempted to explain what causes some students to persist in engineering, and others to leave. A variety of academic and non-academic factors found to influence students' persistence include a sense of community, belonging, and collaboration in their engineering experiences, confidence in their academic abilities, the quality of faculty instruction and mentoring, their perspective on engineering's influence and value in society, sufficiency of pre-college preparation, and the difficulty of courses early in the engineering curriculum [1]-[4]. In general, women and underrepresented minority students are less likely to persist in engineering [5]. Reports also indicate that the persistence of women and underrepresented minority students may be adversely affected to a greater degree by their experiences within the engineering climate than their majority male counterparts. Here "climate" indicates perceptions of student belonging and interpersonal interactions between student peers, students and faculty both in and out of the classroom, and individual compatibility with pedagogical styles in their classes [1], [6]. An undesirable climate also has the greatest impact on student retention in the first years of engineering study [7].

Most students who leave engineering do so within the first two years from matriculation [4], and students' self-reported desire to continue engineering, which is correlated to their persistence, on average declines about two semesters prior to actually leaving [8], while disengagement from engineering-related courses is higher in non-persisting students [9]. However, whereas many interventions and student-active pedagogies are aimed at first-year engineering students, these engaging techniques and supports fall off in the second year, leading to the so-called "valley of

despair" [10]-[12], wherein students are plopped back into the traditional lecture-based classroom, until perhaps their senior capstone experience.

Engineering colleges can positively affect many of the influences on student retention mentioned previously by improving the engineering climate and implementing varied teaching strategies. For instance, the use of student-active pedagogies can increase feelings of belonging among students who are not traditional lecture learners [6] while simultaneously enhancing collaboration between peers and potentially easing the difficulty of the engineering curriculum for some students. In order to broadly affect change in pedagogical practices, we sought to establish a formalized faculty development effort. The literature points to a number of best practices for institutionalizing faculty development in engineering colleges. Felder et al. outlined how to design a faculty development program taking into consideration the structure of the offerings (e.g., workshops vs. seminars vs. learning community), which pedagogical topics to explore, incentivizing participation by faculty, and assessing the effectiveness of the program with respect to its impact on faculty participants' attitudes and practices, and ultimately its impact on student outcomes and retention [13]. Borrego et al. identified factors that can encourage or hinder adoption of new pedagogical practices, in particular lack of needed resources, including appropriate classroom spaces; student resistance to new learning strategies; and faculty resistance to change. Faculty resistance includes concern over increased preparation time, feeling that the efforts in attempting educational innovation are not proportionally rewarded in promotion and tenure considerations, and general skepticism as to the effectiveness of such innovations [14]. However, Atman et al. [5] showed that many of these causes for faculty resistance were overcome by participating in a formal faculty development program – participants overwhelmingly reported satisfaction with the program and felt that participation helped to develop their educational attitudes, practices, and careers.

Approach

The specific goals of this project are to raise faculty awareness of their personal impact on students' learning outcomes and attitudes; to incorporate more 'heads-on' learning earlier in the curriculum; to improve the classroom environment and student learning, leading to increased persistence; to support strong advisor-student relationships; and to enhance students' sense of community, belonging, and collaboration. We have worked to accomplish these goals through faculty development in teaching and learning. Since March 2013, over 70 faculty development opportunities have been organized and offered to the faculty in the Syracuse University College of Engineering and Computer Science through the NSF-funded ECliPSE Program (NSF DUE 1317540). These programs have consisted of multi-day, off-campus workshops; half-day, on-campus workshops; summer workshops and working groups; invited lectures; semester-long book clubs; informal teaching and learning luncheons and happy hours; and interactive sessions at annual faculty retreats. Faculty development opportunities have included introduction of innovative teaching techniques and programs such as POGIL, CATME and Project Based Learning, as well as enhancing knowledge of teaching tools such as Blackboard, Rubrics and Social Media. In addition, the project team developed a Teaching and Learning Blackboard site which provides innovative pedagogy resources, faculty development announcements, and discussion boards that all faculty can access; along with a website where faculty can access

innovative teaching ideas submitted by their colleagues. We continue to assess the impact of faculty development on student learning outcomes, student persistence (as measured by retention and graduation rates), faculty adoption of innovative pedagogies, and the faculty culture with respect to teaching and learning in the College.

Results and Discussion

Faculty Participation and Impact on Teaching

To date, over 75 faculty members have participated in at least one faculty development opportunity provided through our grant. This is approximately 75% of the total faculty in the College. In addition, 16 faculty members have participated in over 30% of the programs offered. Faculty consistently report gains in knowledge, confidence, and likelihood of trying new pedagogies after participating grant-funded activities.

In June 2014, 29 faculty members participated in an intensive three-day Engineering Education workshop. They were surveyed to assess the impact of the workshop on their teaching. Large majorities of the 23 respondents – ranging between 83% and 100% – reported that they had made either "moderate" or "great" gains in each of 11 specified areas of knowledge or confidence related to teaching. In four areas, more than half of the respondents said they had made "great" gains: 20/23 (87%) said so about their enthusiasm for incorporating active learning to a greater degree in their courses, followed by 16/23 (70%) who said so about understanding how to make lectures more active, 14/23 (61%) who said so about their confidence incorporating active learning techniques in their courses; and 12/23 (52%) who said so about their understanding of problem-based learning techniques. Similarly, large majorities – ranging between 91% and 100% -- reported they were either "likely" or "very likely" to implement 5 specified teaching changes as a result of the workshop. In fact, a full 17/23 (74%) said they were "very" likely to revise their course syllabi to reflect more clearly written instructional objectives, followed by 15/23 (65%) who indicated they were "very" likely to increase the degree to which they used active learning in their courses, and 13/23 (57%) who said they were "very" likely to utilize collaborative learning in a course they taught in the following academic year.

In a more recent survey of junior faculty (assistant professors) and faculty teaching 1st and 2nd year gateway courses, respondents rated the extent to which their participation in grant-funded professional development activities has impacted their teaching in a positive way. All but one responded to this question (13/14) and indicated at least some positive impact. A majority of the respondents (9/14) indicated that their participation has impacted their teaching in a positive way to some extent or to great extent.

Impact on Student Performance and Persistence

Over the course of this project, the two-year retention rate in the College of Engineering and Computer Science has increased from 63% to 80%. The four and six-year graduation rates have also increased by 10 percentage points each. Student performance has improved significantly in gateway courses taught by faculty who have participated in more intensive faculty development programs (e.g. multi-day workshops). A number of faculty who teach gateway courses in the College participated in the three day Engineering Education workshop in June 2014. Two years

later, we looked at the percentage of students earning D's, F's, and Withdraws (W's) in five gateway courses for the two years prior to faculty participating in the workshop and in the two years following the workshop. The courses included Introduction to Engineering and Computer Science (ECS 101), Mass and Energy Balances (CEN 231), Statics (ECS 221), Electrical Engineering Fundamentals I (ELE 231) and Electrical Engineering Fundamentals II (ELE 232). The D/F/W rates across these courses dropped by an average of 4.1% in the two years following the workshop. The biggest changes were in ECS 221, where the rate dropped from 17.57% to 11.25% and ELE 232, where the rate dropped 12.59% to 6.67%. CEN 231 also saw a drop of over 5%, going from 18.95% to 13.64%. Early student success in required coursework that spans a majority of degree programs in the College of Engineering and Computer Science helps to support improved two-year retention.

More than fifteen gateway courses in the college have been redesigned over the past five years and we continue to assess the impact of these changes on student learning and attitudes towards persistence and success. This past summer, 14 ECS faculty members participated in a Gateway Course Redesign Working Group with a goal of redesigning elements of their courses and implementing their changes during this academic year. This effort is the subject of another paper at this conference.

Finally, successful academic support services, such as our Academic Excellence Workshop (AEW) courses, have been extended to almost all 2nd year courses in the college over the past five years. AEW courses are peer-facilitated, small group sessions that meet for two hours per week and support specific first and second year course like Calculus, Statics, Dynamics, and Computer Programming. These workshops provide academic support for students in their early coursework, but also provide a supportive environment where students are able to connect to peers and to an upper-class peer mentor (the facilitator). Participation in AEW is strongly encouraged, particularly in the first semester, but is completely elective. However, we found that it is very common for students to participate in this program for multiple courses across several semesters. We looked at retention and graduation rate data for ECS students as a function of their participation in AEW courses and found that students who participate in two or more AEW courses are retained in the college at a rate of nearly 100%.

Conclusions

We have had strong participation in faculty development programming offered through our NSF ECliPSE grant and this work has supported continuous improvement in teaching, learning, and student success within our College. We are continuing this work with the development of a new, comprehensive academic and career advising program in our College and incorporation of diversity and inclusion themes in our work. We continue to work to identify the most impactful faculty development activities and develop a plan to institutionalize these beyond the support of this grant. Above all, we have made great strides towards developing a culture that supports innovative teaching, student-active pedagogies, and support of student success.

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