Work in Progress: New Faculty Experiences in Integrating Retention Support Programming into Teaching

Abstract

Faculty-student interaction on course and non-course matters as well as close coordination between the engineering faculty and academic/student support professionals at a campus are very important to increase the level of engagement and retention in the college environment. Also, this coordination would be very helpful for a new faculty whose responsibilities require a strong commitment with significant time management between participating in teaching, developing a research program, and engaging in service missions. This study highlights the experiences of a new faculty member participating in a collaborative retention program within the university and how the systematic approach implemented helped a new faculty member integrate service and teaching development needs for efficient use of time. The program, called Engineering Connect, was designed for the first-year students in an engineering department with the idea of increasing student success, engagement, and retention. The program was implemented into a Cornerstone Engineering Design course being offered for first-year students in the engineering department. The students were assigned to complete weekly reflections on the course Canvas space on matters related to their learning and campus experiences as an engineering student. The inputs from these weekly reflections were analyzed by faculty each week and an engagement plan was set in place with the students who were identified as needing help and guidance on coursework and/or campus related matters. Also, the students having a successful week were applauded during the classes and were encouraged to keep up with the good work in the courses. The benefits and challenges that new faculty experienced participating in this program are presented with the intention of guiding new faculty members who may be interested in implementing similar programs.

1. Introduction

Engineering graduates remain in demand in the United States workforce and institutes of higher education continue to strive to improve educational practice and experience for engineering students. Issues related to student retention, persistence and academic success remain important topics of discussion and research within engineering education communities. Prioritization of diversity, equity and inclusion also prompts us to pay special attention to success and persistence for groups that remain underrepresented in the engineering profession, including women, African-American, Native American and Hispanic students. Race and gender gaps exist in the persistence of engineering students relative to majority white male population [1], and female students belonging to underrepresented minorities have the highest dropout rate from STEM majors [2]. It is of particular importance to attend to the success and retention of students early in their higher education, and so special attention may also be paid to retention as it pertains to first- and second-year students.

Numerous studies have attempted to quantify, describe and otherwise understand factors that impact student success and persistence toward graduating with an engineering degree. Student attitudes and beliefs are known to be important. For example, student beliefs about engineering career security and salary are predictors for persistence [3]. Student career aspiration has also been observed as an indicator of persistence [2]. Other studies have highlighted the importance of guidance and clarification of the role of engineers through advising, as many students may have incorrect assumptions about the culture of engineering [4]. One study identified six broad factors that drive attrition from engineering: classroom and academic climate, grades and conceptual understanding, self-efficacy and self-confidence, high school preparation, interest and career goals, and race and gender [5].

Mathematics success is also known to be closely tied to student success in engineering. Students commonly rate ability in math and science as a reason for pursuing engineering [6]. As such mathematical ability forms a portion of their identity as engineers, and engineering identity is an important factor in motivation for engineering students [7]. This is also important as female first-year engineering students tended to report lower self-ratings of confidence and experience than male first-year students [6]. The grade students earn in their first college math class has been observed to be related to their probability of graduation [8]. Math performance (and in particular, the grade earned in math) has also been hypothesized to lead to stress about financial aid, which impacts retention [9]. As mathematics may be an early stumbling block for students, the framework of a hero's journey can help form an early conception of engineering that may allow students understand the difficulties that are common during the pursuit of an engineering degree [4] and establish a stronger identity as engineers.

Prior research also highlighted the importance of a support network and connectedness to other engineering students. Valuable support networks can also include the broader university and engineering communities. Mentoring programs help build networks for student support. Studies have used mentoring targeted at improving the retention of female engineering students [10]. One mentoring system also enabled mentors to raise flags to help ensure students were connected to support resources [11], and demonstrated positive outcomes overall, but was especially helpful for women and minorities. Observations suggest that students may be more comfortable seeking advice through peer mentoring programs than by approaching faculty [12]. Attendance at extracurricular events designed to build student campus and community identity was also studied as a method that led to increased indicators of student academic success [13]. Ongoing work is also considering differences in support systems and resources between traditional and non-traditional students [14]. A model for successful transition to college programs featuring five domains (five senses) was proposed by Lizzio: senses of capability, connectedness, purpose, resourcefulness, and academic culture [15]. Programs based on the five-sense model and designed to raise awareness of support services helped create a sense-of-success for first-year nursing students [16] and to support transitions in a Human Physiology cohort [17].

Ultimately, engineering educators share the goal of improving student success and retention and various programs have been implemented to achieve that goal. One study detailed five strategies for progress in programming: improving math and physics foundation, making the

curriculum more hands on, increasing use of technology in classes, building community and fostering teamwork [18]. Multiple programs have targeted peer mentoring and advising, and professional development workshops, for example to increase retention of women and Hispanic students [19], and to benefit a small liberal arts university [20]. A similar, successful retention program at the University of Illinois at Chicago was based on mentorship, co-curricular experience and workforce placement [21]. A first-year program for engagement with robotics and materials design was successful with increasing engineering interest in high-achieving participants [22].

There are also studies highlighting the positive effects of student faculty interactions on student retention rate, student culture and academic success [23]-[24]. The significance of faculty support or faculty interaction on student engagement was studied by Wilson et al [23], who showed that faculty interactions with students help students' emotions and motivations toward greater achievement. The effect of interaction became more important for underrepresented students. Macaluso et al [24] describe results of a faculty survey from professional development programs on engaging faculty in student success. Participants' level of knowledge and/or depth of thinking about implementing high engagement strategies was increased by the activities.

This paper describes the experiences of a new engineering faculty member implementing success programming, specifically the new Engineering Connect program, which was piloted in 2022/2023 at Penn State Hazleton for the purpose of improving engineering student success and retention. Recognizing the importance to retention of identity as an engineering student and future engineering professional, academic success (especially in math), and building a support network within the engineering community, the program attempts to assist first-year students transitioning from high school to a college engineering education environment. This paper specifically focuses on the experiences of early-career engineering educators who participated in the Engineering Connect program. It highlights the benefits they gained from the program, such as improvements in their teaching, research, and service activities, as well as the challenges they faced while implementing the program in their coursework.

1.1. Engineering Connect Program

To respond to retention challenges that colleges and universities nationwide continue to grapple with – promoting student's sense of belonging, eliminating barrier courses, providing equitable support to students, getting students to connect to and utilize support resources early in their academic careers – Engineering Connect was conceptualized to improve the persistence and retention of first-year engineering students at the institution. At its foundation, Engineering Connect leverages the academic structure of the cornerstone courses that first-year engineering students complete at our institution. Furthermore, Engineering Connect utilizes existing resources available at the institution and strives to support and not compete with the existing and successful persistence programming and events currently delivered to first-year engineering students at the institution. Additionally, Engineering Connect has the aspiration that all first-year engineering students at the institution will benefit from the program. To realize the mission of Engineering Connect, four program goals have been established:

- *Program Goal 1: Advance student growth by building on math fluency and teaching students how to learn.*

Math is important to success in engineering. Therefore, Engineering Connect offers instructors a framework for incorporating academic support within the cornerstone math courses completed by first-year engineering students at the institution. This framework informs instructors on how to assist students with thinking about and understanding their learning progress within the math course and offers guidance on how to inform students about the available resources at the institution which can support their success within the course.

- *Program Goal 2: Develop behaviors, attitudes, and beliefs that promote academic persistence and support the mental, emotional, and financial health of students.*

Many of the challenges that students experience as they are transitioning from high school to college can be addressed by the existing resources available at our institution. These resources include, but are not limited to, counseling and health services, tutoring programs, advising, career services, and financial aid. However, students do not traditionally access, or students underutilize these resources early in their first academic semester. In response, Engineering Connect supports the transition challenges faced by first-year engineering students by educating instructors of the available resources at the institution, offers instructors with techniques to expose students to the available resources, and offers advice on how to encourage students to utilize the resources early and often throughout their first year.

- *Program Goal 3: Nurture opportunities to build academic and social connections and to promote identity development for students.*

We want engineering students to identify themselves as engineering majors and relatedly, we want students to connect to the engineering profession. Engineering Connect provides faculty with activities to support students with deepening their knowledge about the skills they will develop related to the students' goals of pursuing engineering. Also, Engineering Connect provides faculty with strategies on how to encourage students to see themselves in the field of engineering. Additionally, Engineering Connect strengthens the connection between faculty and existing student support professionals. This connection enhances how faculty support students in major and career exploration and with building the foundation of a career resume.

- *Program Goal 4: Cultivate an environment that celebrates diversity, employs inclusive practices, and encourages student confidence, resiliency, and sense of belonging.*

Students have varied backgrounds and this variance in experiences prior to arriving at our institution influences the type of support a student will need within their first year. Engineering Connect provides instructors with techniques to incorporate equity-minded principles into their courses and strategies for supporting populations traditionally marginalized in engineering, strategies that ultimately benefit all students within the course.

Engineering Connect also offers instructors opportunities to help students develop confidence and resiliency and strategies to help increase a student's sense of belonging to the course, institution, and engineering profession.

With these four program goals, Engineering Connect aims to impact the persistence of first-year engineering students by providing instructors with a framework to deliver academic support within the cornerstone engineering courses. Moreover, Engineering Connect strives to increase the dissemination of academic support information to students; to increase the exposure to and utilization of existing services and programs available to students at the university; and to cultivate a culture of belonging and a culture of equitable support for all.

2. Methods

The Engineering Connect program was piloted in a Cornerstone Engineering Design course in the fall 2022 semester. As a first-year engineering course, Cornerstone Engineering Design provides students with a foundation for engineering design through hands-on team projects that address specified design opportunities. Students use a range of design tools and techniques to carry out and communicate their design processes as applied to their projects. Additionally, students develop and practice professional skills, such as communication and teamwork. A total of 32 students who registered for the course participated in the Engineering Connect program. Each week, the students were asked to provide reflections, mainly on three different themes: reflections related to (i) their course/learning progress, (ii) availability and use of the existing resources at the university, and (iii) student confidence, resiliency, and sense of belonging. Students were asked to complete reflection assignments on these themes on a periodic basis throughout the semester. The reflections consisted of questions using a five-point scale rating (strongly agree (5) to strongly disagree (1)) and open-ended questions. The weekly reflections were completed by the students on the course Canvas space, with a response rate ranging from 70 to 100%, depending on the week. The inputs from these weekly reflections were analyzed by faculty each week. The faculty also received an email from the Engineering Connect program director that summarized the results from reflections and provided some suggestions for follow up. Based on the outcome of the reflections, an engagement plan was set in place with the students who were identified as needing help and guidance on coursework and/or campus related matters. Also, the students having a successful week were applauded during the classes and were encouraged to keep up with the good work in the courses.

3. Faculty Experience

Early career engineering faculty experience significant demands on their time related to balancing research, teaching and service activities. While new faculty may value and prioritize student success, it is important that student success initiatives that they undertake allow them to participate efficiently and in a way that synergizes with their other activities as a faculty member. The Engineering Connect program was implemented in a course taught by an early career faculty member, during their time on the tenure track and offered some benefits in that regard. The following section details that experience from the perspective of impacts on new faculty workload and additional benefits that participation in the program offered to career and professional development.

3.1. Program Benefits on Teaching

The weekly reflections provided an opportunity to further improve the course content and the method of creating the groups for class activities and projects and following the progress of students on their group project. Some specific examples are provided below.

Monitoring in-class success on course learning objectives

The weekly reflections were helpful for faculty to provide targeted learning objectives and guidance. For example, one of the reflections asked students what skills they think engineers need and their confidence level of possessing the skills to become an engineer. Based on the outcome, the faculty specifically highlighted some of the characteristics/skills that make successful engineers such as communications skills and ability to work as a team. The reflections helped the faculty to track the students' progress and offer additional help in a timely manner. For example, the students were asked to reflect on one success they had in the course in a particular week. Although the majority of students indicated they were getting better with SolidWorks skills, some students (3) were having difficulties with SolidWorks labs. Thus, the faculty provided additional help to these students, and also created small working teams to facilitate the learning of students.

Improving advising approaches

Additionally, 7% of the students shared that they disagreed with the statement that they have skills to be successful engineer. One-on-one discussion with those students revealed that these students were having difficulties with their Math classes. In addition to encouragement, the students were reminded and directed to the resources available to them on campus. Follow-ups were made with each student after a few weeks, and the students indicated they were utilizing the resources on campus, and that it was helping with their classes.

Assessment for improvement of future teaching practice

At the end of the semester, the students reflected on what their favorite project was and why. The majority of the students highlighted the project that involved designing a low-cost robotics system that can complete a job considered to be dull, dirty, and/or dangerous. The students shared that they enjoyed the experience of working on a problem that is neither too vague nor too specific, and that provides freedom to choose the topic based on their interests as a team. On the other hand, a few students (5) preferred an individual SolidWorks project where they were assigned to create a 3D model of one object they choose to demonstrate autonomy and problem-solving skills. The results show that students enjoyed the projects when they were involved in defining the problem/topic. The faculty will accordingly update class activities and hands-on activities for the next time the class is offered.

Improving practices for assigning group work

The reflections on the sense of belonging in the classroom and campus gave an idea to faculty how to create the groups for the class. When a follow up was made with the students

who replied to “strongly disagree” to the belonging questions, they mentioned that they did not know most of their classmates and did not spend time outside of the class. Thereafter, the faculty switched up the teams for every class activity. This provided an opportunity for the students get to know each other and create friendly and engaging environment. For a group project later into the semester, the faculty inquired if the students wanted to form their own groups or have any preference, the significant majority indicated that they feel comfortable to work with anyone in the class.

Helping faculty monitor and react to group dynamics during teamwork activities

The reflections were also very helpful to identify and address any issues arising during the group projects. These were good case studies to highlight some of the specific outcomes of the projects, such as ability to work effectively and efficiently in a team environment. For example, the faculty was able to identify the team(s) having concerns about functioning effectively (e.g., particular team member not undertaking his/her tasks on time, certain individuals dominating the discussions during group projects) and this was addressed in the class by emphasizing the importance of working as a group and time management skills. The faculty also revised the report submissions requirements accordingly.

The Engineering Connect program helped the faculty to play a role in student engagement, success, and sense of belonging without requiring a substantial investment of time.

3.2. Program Benefits on Research

The faculty had a chance to collaborate with other faculty and Engineering Connect developers in this paper to analyze the results and showcase how these results and experience can be helpful to new faculty members who may be interested in implementing similar programs. Also, the program allowed the faculty to experience growth in teaching and service responsibilities without having a big impact on faculty time, which provided more time for research.

3.3. Program Benefits on Service

While new faculty members may gain some experience in teaching in graduate school, there may be new and unfamiliar responsibilities that may require extra time to learn to serve the school and students. New faculty members may also require time to get accustomed to the organizational and cultural structure of their university. The Engineering Connect program with its built-in activities provides an opportunity for new faculty members to become familiar and interact with individuals and departments across the university. This facilitates university-wide collaborations for student-centered timely intervention services. For instance, in the one of the reflections, the students were assigned to watch the videos that have been developed to give them insights into the engineering majors offered at our university and asked if they were confident about the area of engineering that they want to pursue. A response rate of 91% was achieved for this reflection and the majority of the students (76%) indicated their confidence. The remainder of the students (24%) were provided with opportunities to interact with the advising and career services on campus. In addition, the feedback from these reflections were anonymously shared

with the advising center to organize more targeted activities or modify the existing programs based on student needs identified from the reflections. For example, students were highly encouraged to participate in major/career days held on campus and more detailed information and insights regarding the major and minor programs were provided for students to continue exploring their engineering career interest. Moreover, the feedback from the reflections on students' needs of sense of belonging in the classroom and campus helped a campus retention committee to organize various events on campus to create a friendly environment and a network on campus.

3.4. Challenges and Limitations

The participation rate in weekly reflections varied by week. The rate significantly dropped during the exam weeks. Since the time to complete the reflections is relatively short, time can be allocated during the class to allow students to submit their reflections during the exam weeks. The faculty member had sufficient expertise and familiarity with the university resources to address most analyses of the reflections related to the university, engineering major, and course, as well as identifying appropriate responses to student needs. On the other hand, certain topics may not fall within the immediate expertise of faculty members and the faculty may need to be provided with some resources for additional help and guidance. For example, it was challenging to address the reflection outcomes on awareness and mitigation of bias. Identifying such topics with the faculty prior to the semester and providing resources and instructional strategies for such specific topics might be very helpful. In that sense, participation in this type of program could potentially be a means to identify needs in professional development or mentorship for new faculty members.

Additionally, it should be noted that the Engineering Connect program was developed by the academic and advising center and thus, the reflections here do not represent the workload that could be faced by a faculty member developing these activities independently. While the reflection activities utilized in the program were very beneficial to new faculty member development, the development of such reflections independently could be a workload challenge for faculty members, considering the diverse range of topics and themes addressed in these reflections. Thus, it is essential to consider the potential limitations that may arise when such programs are not available, and to explore alternative means of supporting faculty members in their efforts to implement effective reflection activities.

4. Conclusion

Engineering student success and retention is one of major focus areas for many universities in the United States, as significant number of engineering students drop out or change their major at the end of their first year. To combat this, universities explore means to improve student success and retention in engineering. In this study, a new faculty documented experiences and challenges of integrating a retention program into first year engineering course. This study highlighted the benefits of the program for the faculty in teaching, service and research without having a big impact on their time. The implemented program provided opportunities to improve various aspects of teaching. For example, the program helped the new

faculty effectively and efficiently monitor in-class success on course learning objectives and group dynamics during teamwork activities, improve advising approaches and practices for assigning groups work, and assess means to improve future teaching practices. Faculty can also benefit from similar programs such that more time can be allocated for research. Moreover, participating in such a program can result in collaborations with departments and individuals across the university for various student-centered service activities that benefited from the outcomes of the implemented program. The study also highlighted potential challenges and associated suggestions for program improvement.

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