A Holistic Approach to the Freshmen Engineering Experience

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Abstract - **All engineering schools must strive to evolve a new paradigm for undergraduate education that recognizes the evolution of the skills and learning styles of its incoming students and prepares them to tackle society's grand challenges of the future, while at the same time increases the probability of their success in their chosen engineering program. Most researchers and experts in the field agree on some basic tenants of retention, which include developing community amongst freshmen, creating connections for freshmen through meaningful interactions with returning students and faculty, engaging freshmen in active learning environments, helping freshmen understand and internalize the vision and mission of the school, and assisting freshmen to develop a personal identity as an Engineer [1,2,3]. This paper describes a holistic approach to the freshmen year developed over the last few years which includes and integrates an engineering camp, new freshmen courses, a career exploration event, undergraduate teaching assistants, an engineering residential community and intensive advising.**

Index Terms – Engineering camp, Freshmen retention, Active learning environments

BACKGROUND

New freshmen engineering numbers have been increasing by over 200 students each year for the last 5 years with close to 1600 new freshmen joining our engineering school this fall. At the same time the school is rapidly growing there has been an intensive effort to improve the quality of the freshmen engineering experience both in and out of the classroom with the goal of improving retention as well as immersing students within engineering activities from the first day.

Our engineering school itself is not organized around traditional departments but instead consists of 5 schools, each of which contains faculty and students working together on theme based research and curricula. For example the School of Computing Informatics and Decisions Systems Engineering integrates faculty and students in the computer science, computer systems engineering, industrial engineering, engineering management, and informatics degree programs.

THE FRESHMEN ENGINEERING EXPERIENCE

The following sections describe the activities both in and out of the classroom that our school has introduced over the last 5 years. The goal has been to create an outstanding engineering education experience from day one. The activities are integrated as a part of a holistic strategy. Our philosophy is that we are "building engineers from day one" and all of classroom and out of class experiences reflect this approach.

I. Freshmen Engineering Camp

In the summer of 2008, the Ira A. Fulton Schools of Engineering at Arizona State University (ASU) made a strategic decision to take deliberate action towards improving the undergraduate student experience by requiring all incoming freshmen to attend a three day/two night camp in the local mountains approximately one hundred miles from campus prior to the start of the fall semester. ASU's Engineering School designed E2 Camp to be the cornerstone of a new engineering freshmen experience. The engineering school designed its programming and staffing at E2 Camp specifically for the purpose of meeting the desired outcomes of creating community amongst freshmen, bonding freshmen with returning students, creating opportunities for meaningful interaction between freshmen and faculty both in and outside of the classroom, helping freshmen understand and internalize the vision and mission of the school, and fostering students' understanding of how they can apply their academic experience both as undergraduates and after graduation.

All of the programming and activities during E2 camp have the underlying goal of building community amongst our incoming freshmen. The freshmen live in cabins together and participate in team based activities. The freshmen also engage in cabin vs. cabin design and performance competitions, such as water balloon launchers and rubber band cars, which foster camaraderie through team work and fun and spirited competition. Free social time in the evenings provides options like S'mores at the campfire, lighted volleyball courts, ping pong, board games and other directed activities that encourage the freshmen to build community amongst themselves. Additional activities such as "major lunch" provide opportunities for students to connect with other students in their major.

An equal focus is placed on building community with current returning students which serve as peer mentors.

One peer mentor leads each cabin of students and functions not only as a mentor but as a group member as well. Participating in all of the activities with their cabin throughout the three days of camp, each mentor builds a strong rapport with the students. After each activity the mentor debriefs with the students how that activity's process and outcome apply to the students as they transition from high school to the university. During down times, the mentors have the opportunity to talk with their group about their experiences as undergraduate engineering students and convey to the students the things that have been most impactful to their own academic and personal success. The freshmen also see how the group of mentors themselves form a community bonded by the common experience in the school of engineering. Although not a specific part of our programming, many of our mentors have maintained communication with their freshmen via email, Facebook, and meeting over lunch. The interaction with the mentors helps build student commitment to engineering.

Students also have an opportunity to engage with faculty at camp in both formal and informal activities. One formal activity is organized around the student's program, bringing freshmen, faculty and peer mentors together to discuss opportunities within their program to engage in research, service learning and student organizations.

The cost for running the camp is about $200.00 per student of which each student is charged a $50.00 fee. More details about the camp can be found in our ASEE paper [4].

II. Freshmen Engineering Career Exploration Event

Back on campus early in the fall semester, all engineering freshmen attend an Engineering Career Exploration event designed to help our freshmen develop a personal identity with their chosen degree programs and/or to help them explore other engineering programs. Our Engineering Career Center—already heavily engaged in career services for our students with very successful career fairs, career development programming, and strong industry relations—engaged our freshman students in the Engineering Career Exploration event which introduced them to industry partners and alumni in a fair-type atmosphere.

Based on the premise that "informed and considered career decisions result in improved matches between people and their work" [5], we developed the following specific goals for the Engineering Career Exploration Evening.

1. Students learn details from industry partners about their chosen field of engineering study as well as others.
2. Students learn to prepare for and conduct informal interviews with industry partners.
3. Students learn an array of career pathways from industry partners.
4. Students gain advice from industry partners regarding building their undergraduate engineering portfolio.
5. Students learn from industry partners the skills that are important to an engineer.

Besides the formal outcome intended for our freshmen, the Engineering Career Center utilized the event as a relationship-building opportunity while our industry partners benefited through brand recognition and building relationships with future engineers. More details about this event can be found in ASEE paper along with detailed assessment results including the results that showed confidence in choice of major prior to and after the event, on a 4-point scale of 1=not at all confident to 4=very confident, 41% reported being "very confident" after the event compared to 30% before and that 89% of the participants would recommend that others attend [6]. The challenge in creating an event such as this is obviously ensuring adequate participation from companies for all of the engineering programs. Each organization must also send enough representatives to ensure effective communication with the students.

III. Freshmen Engineering Course Redesign

In our engineering program all of our freshmen are admitted directly into the engineering discipline of their choice. Prior to the introduction of these new courses, freshmen students in each of the academic programs took a discipline specific introduction to engineering course. The content and instruction of each of these courses varied greatly both by design as well as quality of instruction. As part of a renewed commitment to improve our freshmen engineering experience incorporating the latest best practices, all aspects of these courses were analyzed leading to the new approach described in this paper.

The discipline specific 3 credit hour Introduction to Engineering course was changed to an experiential multidisciplinary 2 hour lab and lecture course (FSE 100) complemented with a 1 hour engineering success class (ASU 101) both of which are described in detail later in the paper. Rather than create a common course that all freshmen would take, the FSE 100 classes are theme based closely aligned to the schools with projects that are closely tied and very relevant to the students' majors. The instruction of the new FSE 100 courses is primarily performed by a core of lecturers specifically hired to work together in the instruction, evaluation, and continuous improvement of the courses. The classes are taught in a newly constructed classroom environment (eSpaces) in class sizes of 40 to maximize instructional effectiveness. The new innovative eSpaces provide a collaborative learning environment in which students sit at work tables in teams of four to complete a variety of hands-on engineering activities and projects. In eSpace, student teams have the opportunity to use electronic equipment, sensors, computers with engineering software, and hand tools to visualize designs, complete analysis tasks, and build prototypes. Throughout eSpace there are whiteboards and writeable glass wall panels to encourage student collaboration. All furniture in the room is mobile, with wheeled tool cabinets and

demonstration tables, to make eSpace modular allowing for a variety of activities and courses.

One of the biggest concerns faced in the redesign of the courses was resistance from discipline specific faculty who were fearful that the loss of contact with their students could lead to retention issues. This concern was addressed via the ASU 101 class as well as ensuring that one faculty member from each program was also involved in the instructional team.

All of the classes also utilize Undergraduate Teaching Assistants (UGTAs) who are current engineering students that are selected to assist in problem based instruction and to serve as role models. Each UGTA works alongside a Graduate Teaching Assistant (TA) and the faculty instructor to instruct and assist students in the laboratory portion of the course. UGTAs interact with the students primarily in class, answering questions, and offering assistance and suggestions as needed as students complete various engineering lab activities and design projects. As a near peer, the UGTA is able to relate well to students and their difficulties and successes, and offer them valuable insight that may help improve student motivation and confidence.

Since the program's inception in fall 2009, more than 120 students have worked with over 50 faculty members, and feedback from students and faculty has been overwhelmingly positive. Over the last three years, with guidance from faculty and students, the program has evolved from a volunteer opportunity that provided little training and guidance for UGTAs to a paid experience with built-in oversight and deliberate efforts to improve teaching, learning, and skill development. The program has become increasingly institutionalized within the School of Engineering, and visibility of the program increases with each semester.

UGTAs are sophomore and upper-division undergraduate students in good academic standing who spend about three to five hours each week working with an engineering class. UGTAs meet with their faculty instructor to prepare for activities, assist their faculty in facilitating classroom active learning projects, and may hold office hours or review sessions throughout the semester. Through their presence in the classroom, UGTAs:

- Promote more effective learning and achievement through peer mentoring
- Act as a cultural bridge to transition from high school to the university environment
- Help students to navigate the institution
- Promote self-confidence and self-reliance by promoting available resources
- Act as role models who demonstrate personal and academic success.

Further details on our UGTA program can be found in our ASEE paper [7].

Unlike the FSE 100 classes, the ASU 101 classes are discipline specific and are typically taught by tenure track faculty with a class size limited to 19 with the goal of achieving a high degree of faculty-student interaction. The ASU 101 class is where students in the same major will build a community and identify most closely with their chosen profession.

The specific learning outcomes for ASU101 are all related to students gaining the skills they need to be successful students and professional engineers. These outcomes are those typically covered in introduction to engineering courses at other institutions that are not covered explicitly in our introduction to engineering course (FSE100). As a result of completing ASU101, students will:

1. Set Personal, Academic, and Career Goals to guide their success at ASU;
2. Learn about the resources available through ASU and the Ira A. Fulton Schools of Engineering that will help them to be successful in their academic careers;
3. Enhance skills to support academic success (time management, academic/career planning, study skills);
4. Understand the ethical issues related to a career in engineering and the role of academic integrity in becoming an ethical and responsible professional engineer;
5. Gain an understanding of the exciting career options available in engineering and what they can do as engineers; and
6. Become a part of the engineering community and learn about ways to become more involved in the School's and University's culture

IV. Freshmen Engineering Residential Community

All Engineering freshmen are required to live in an Engineering Residential Community (although exceptions are made). First-year students have the opportunity to enrich their academic experience outside the classroom by living in the engineering residential community. The Engineering residential community provides students with access to academic resources such as tutoring and study groups as well as social activities, intramurals, gaming nights and meals with professors. These academic and social activities are designed to help build relationships with peers, mentors and faculty. Additionally, students have access to Peer Mentors, who are upper-division engineering students living in the community. The peer mentors are there to serve as a resource to the residents and to assist in the planning of academic and social activities. The programming is conducted by Engineering staff under the direction of the Associate Dean for Academic and Student Affairs in Engineering in collaboration with Residential Life who provides funding.

V. Intrusive One on One Academic Advising

Each entering undergraduate student in Engineering is assigned an academic advisor to work with from admission to graduation and beyond. Academic advisors help students successfully transition to the University and make progress

towards their educational goals and graduation. Advisors are part of the educational process, providing academic information and guidance to help students understand curricula, policies, and procedures. Working with advisors, students identify academic and career goals, create and implement plans, and assume responsibility for their education. The Fulton Schools of Engineering have implemented a comprehensive advising assessment plan which provides on-going advising throughout the year. Advisor workload is monitored to maintain a 1:300 target ratio of advisors to students.

Advisors have a variety of technologies that assist with retention of undergraduates. In 2008, the Provost's Office led the development of eAdvisor; a web based system that tracks student progress toward graduation each semester. Students and advisors can easily see if a student is on or off track in their program. This year, the Provost's Office in conjunction with members of the enrollment management committee led the development of a Retention Dashboard. The dashboard allows advisors to identify their students by various attributes that typically correlate with non-persistence and proactively reach out to them.

Faculty are also engaged in the advisement process providing assistance to students in selecting elective classes, career counseling and graduate program advisement.

ASSESSMENT

Progress toward retention goals is reported both annually and from semester to semester for freshman. Official high level reports are provided by the Office of Institutional Analysis. Detail breakdowns by gender, ethnicity, engineering program and activity participation are prepared annually by staff under the direction of the Associate Dean for Academic and Student Affairs in Engineering. Efforts are supported by dashboard technology as well as an ad hoc reporting environment. Freshman retention goals are communicated to each engineering program and recently were increased from 90% retention at the University to 91% and 80% retention in Engineering. A few examples of the metrics tracked are shown below:

- University First-Time Full-Time Student (FTFT) retention rate continues to improve as well as that within engineering.
- Females and underrepresented populations are retained at a level consistent with the general population
- e2 camp participants are retained at a 10% higher rate
- 6 year graduation rates continue to rise

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