Innovative Classroom Experiences and Peer Mentor Support Systems for First Year Engineering Students

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Work-in-Progress: Innovative Classroom Experiences and Peer Mentor Support Systems for First Year Engineering Students

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***ABSTRACT*- An engineering program in southwest Oklahoma is growing exponentially and the department needs to capitalize on that growth in order to sustain it. In Oklahoma there is an expected 15.4% growth in architecture and engineering careers from 2008 to 2018 according to The Oklahoma Employment Security Commission, Economic Research and Analysis Division [1]. Regional university engineering programs serve as pipeline programs for students in rural areas to attain degrees and secure job placement in the growing STEM career opportunities in Oklahoma. This university's engineering program offers five engineering disciplines for an AAS in Engineering: Mechanical, Industrial, Electrical, Civil and Environmental. This program began in 2014 and has had 24 graduates to date. The program's ability to retain students past the first year is essential. The course load is heavy with approximately 18 hours per semester expected for a student to stay on track in the program. The Engineering Program utilizes innovative classroom experiences and peer mentor support systems in the first year engineering program. First year engineering students experience ENGR 1411 (Introduction to Engineering) and ENGR 2113 (Statics). An open-ended project is presented to ENGR 2113 students where they are tasked to demonstrate a concept learned in statics. This requires the student team to design and build in order to demonstrate. Chapter exams were revamped into 50/50 competencies. These competencies are content based versus chapter based which enhances a student's connection within content. Finally, the development of the Engineering Learning Laboratory for Statics allows upperclassmen to mentor and support first year engineering students.**

THE PROBLEM

A study from 2014 found that students in a traditional style classroom are 1.5 times more likely to fail in STEM curriculum than those that are in active learning classrooms [2]. Thus classroom engagement is important for retention of students in rigorous programs such as the engineering program at Cameron University. Also, critical attrition points for Cameron University overall as well as in STEM programs are persisting from the freshman to sophomore year and completing degree programs within three or six years based on Associate or Bachelorette level. Cameron University has a retention rate of 65% for first-time, full-time baccalaureate degree seeking freshmen in Fall 2016 returning in Fall 2017; and CU has a graduation rate of 23% for first-time, full-time baccalaureate degree seeking students from the Summer/Fall 2010 cohort [3]. Therefore, at the local level there is a need to increase persistence of freshmen to sophomore level students.

OVERVIEW OF PROPOSED SOLUTION

Cameron University must retain a greater percentage of students in the Cameron University Engineering Program. This study proposed that the use of innovative classroom experiences and peer mentor support systems for first year engineering students will increase student engagement and thus retention. Cameron University has employed three distinct forms of classroom engagement: field experiences, projects, and assessment through competencies. Field experience began in the fall of 2014 while the projects and competencies began in the fall of 2017. First, freshman engineering students are provided with four real world engineering experiences during ENGR 1411 – Introduction to Engineering. The first experience is an environmental engineering field day where students learn what engineering looks like from a field engineering standpoint. The second is a manufacturing engineering tour where students learn about the

numerous engineering disciplines that are needed in a manufacturing setting. The third trip is to a military installation where students see mechanical and electrical engineering in action through simulators. On the fourth trip, students participate in a field experience with city engineers. This experience includes both in process and built city projects, roadway design, and low impact development structures and more. Students gain an understanding of the entire process from project request, to design, to permitting and finally construction. These four experiences allow students to feel "part" of the program and begin to make connections with their cohorts and professionals whose endorsement will be vital when entering the workforce. The interaction with industry from day one provides high impact learning, student engagement, and connects the classroom experience to the profession of engineering.

In addition to the field experiences, students are encouraged to deepen their understanding of engineering though open-ended projects. The projects are designed to discover the real art of problem solving by first defining "the problem" as a team. In 2018, ENGR 2113 – Statics students were asked to design and construct a truss or crane system that would hold a point load of 1000 g. The materials available were drinking straws and pin fasteners. Students were also required to provide the documentation that their designed system was mathematically sound, meaning they were tasked to show all relevant calculations by hand using either method of sections or method of joints. Students were provided a rubric and are required to present their design to an evaluation panel of local engineering professionals. This open-ended project concept is further developed in ENGR 2223 (Fluids), ENGR 2533 (Dynamics) and ENGR 2213 (Thermodynamics). The primary goal for this classroom adaption is to include experiential learning and in doing so ensure more students are able to progress successfully through their engineering curriculum. With a greater focus on concepts and application, the expectation is that students will be better prepared for industry.

The idea of content based competencies versus chapter exams was introduced at the 2017 FYEE Conference [4]. During the fall of 2017 Pass/Fail competencies were used in place of chapter exams. Competencies are graded from a rubric and all students must pass all competencies in order to pass the class. Each student is allowed to retake a competencies one time if they did not pass it the first time. For example, in Fluid Mechanics a competency was developed that covered all types of pressure problems. This involved a variety of topics not just manometers or the use of Bernoulli's equation. In the Spring of 2018, in Statics instead of testing chapters 1, 2 and 3; a competency was developed to cover all concepts and problems solving techniques required regarding truss problems. This competency involved topics like, two force members, reaction forces, method of sections, method of joints just to name a few. The use of competencies encourages students to focus on the overarching concepts of the material, with the expectation that students will have a deeper understand of the engineering concepts covered.

In 2016, a grant provided funding to develop the Engineering Learning Laboratory for Statics. This lab was staffed by one second year student. This student provided a minimum of ten open hours per week throughout 14 of the 16-week semester. In 2017, funding was not available. In 2018, the laboratory reopened with two second year students with 20 hours of availability weekly throughout 14 of the 16-week semester. In addition, these students held bi-monthly review sessions and additional review sessions prior to each competency. The laboratory primarily focused on freshman and sophomore engineering courses.

PRELIMINARY DATA AND ANALYSIS

Based on course evaluations, students in ENGR 1411 appreciate the opportunity to connect with industry. 80% of students persist in the engineering program past ENGR 1411. Notably, the main reason for the 20% loss is completion of calculus 1 and/or a change of major. This data is collected from responses on course evaluations and conversations with students during enrollment meetings.

Projects began in the fall of 2017 and have been developed in Statics, Fluid Mechanics, Dynamics, and Thermodynamics. Open-ended projects have been perceived as positive for both the students and the industry partners that evaluate their projects. This has also led to increased number of internships and greater pay offered to CU Engineering students during 2018 as compared to 2014 -2017 (***Figure 1***).

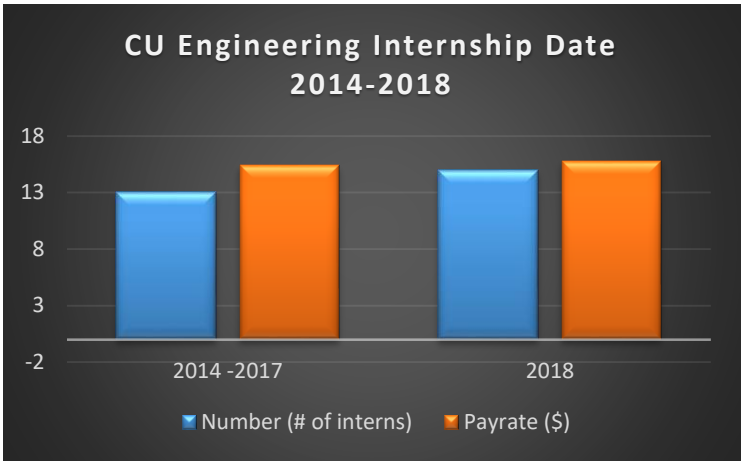

Figure 1 – CU Engineering Internship Data 2014-2018

Competencies were piloted in Fall 2017. During this semester, competencies were strictly Pass/Fail. Meaning, if a student received at least a 70% based on the rubric they were rewarded with a Pass, equivalent to a 100% for that competency. Course evaluations after the fall semester indicated students appreciated the change to content based exams instead of chapter based exams, but were unsatisfied with the strict P/F concept. Beginning in Spring 2018, competencies have been revamped to 50/50 representation. 50% of the grade is based on Pass/Fail, meaning if you score a 70% based on the rubric you receive all 50 of the points available. However, the other 50% is representative of your actual grade. Thus if you scored a 72% on the rubric you would receive 36 points from actual grade (72% * 50%) and 50 points from the P/F, totaling an 86% for the competency grade. Anecdotally, students in all engineering science courses during the spring of 2018 are satisfied with this change. The data from course evaluations in May 2018 support this change.

Preliminary data supports the used of the Engineering Science Learning Laboratory as scores on exams are higher for those that use this laboratory versus those that do not. These methods have been assessed in two student cohorts and the data to be presented is preliminary with a sample size of approximately 15 per cohort.

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